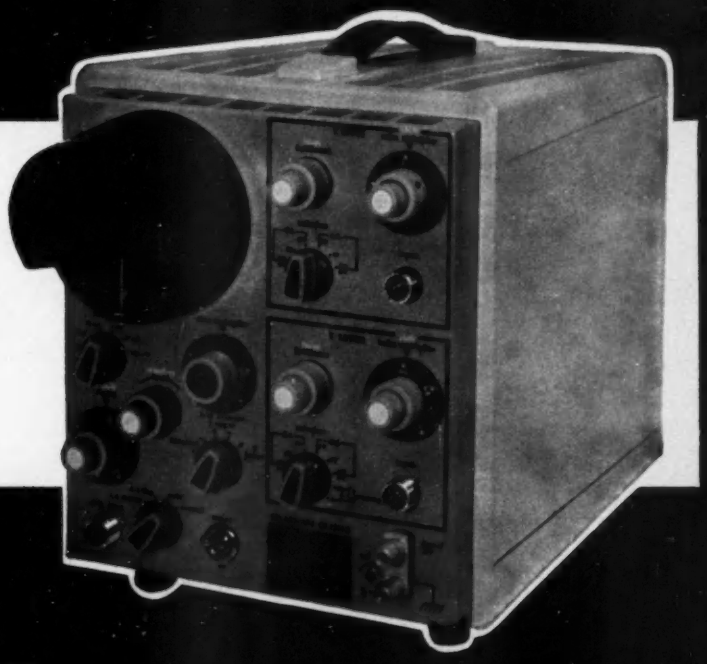
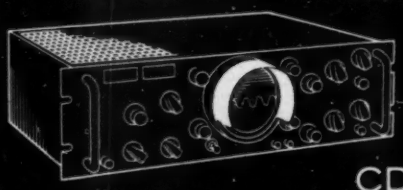
Electronic Engineering

SOLARTRON **CD 1014.2**

the most widely used oscilloscope

DOUBLE-BEAM D.C.-5 Mc/S
LIGHTWEIGHT PORTABLE





CD 1016 ALSO RACK MOUNTED VERSION ON 5¼ INCH PANEL

EE 35 J02 *for further details*

NPN DIFFUSED JUNCTION

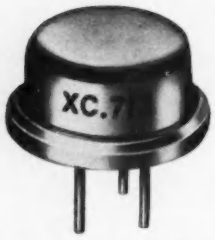
SILICON POWER TRANSISTORS

2 TO 30 WATTS DISSIPATION AT 100°C

OUTSTANDING FEATURES

- ★ Extremely low saturation resistance
- ★ High current and power dissipation ratings
- ★ High beta at high current
- ★ High temperature performance (up to 175°C)

LOW POWER TYPES



MEDIUM POWER TYPES

HIGH POWER TYPES

	XC703	XC713	XC723
Maximum collector/base voltage (volts)	60	60	60
Maximum emitter/base voltage (volts)	12	12	10
Minimum h_{fe} (V_{ce} = 4V, I_c = 200 mA)	15	—	—
(V_{ce} = 4V, I_c = 750 mA)	—	15	—
(V_{ce} = 4V, I_c = 1.5 A)	—	—	10
Average f_α (V_{cb} = 28V, I_c = 5 mA) (Mc/s)	1.5	—	—
(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	—	1.25	—
(V_{cb} = 12V, I_c = 100 mA) (Mc/s)	—	—	1

Have you our latest transistor data sheets? A request on your business notepaper will bring you a set made up to date.

EDISWAN SEMICONDUCTORS

MAZDA

Associated Electrical Industries Ltd
Radio & Electronic Components Division
Semiconductor Department
155 Charing Cross Road, London, W.C.2 Telephone: GERrard 9797
TAI5/87

Vol. 33 No. 401

JULY 1961

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

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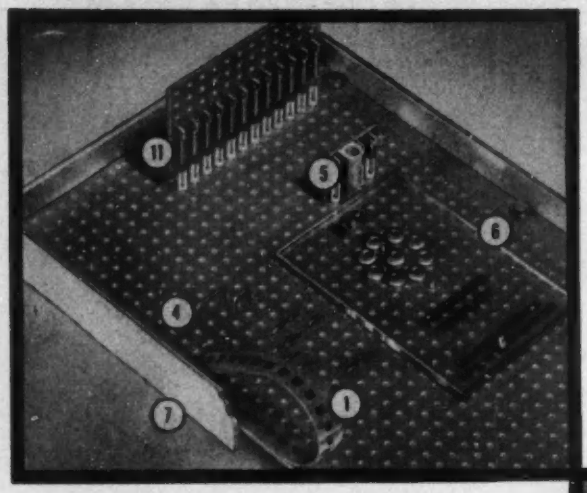
PUBLISHED MONTHLY on the last Friday of the preceding month by:

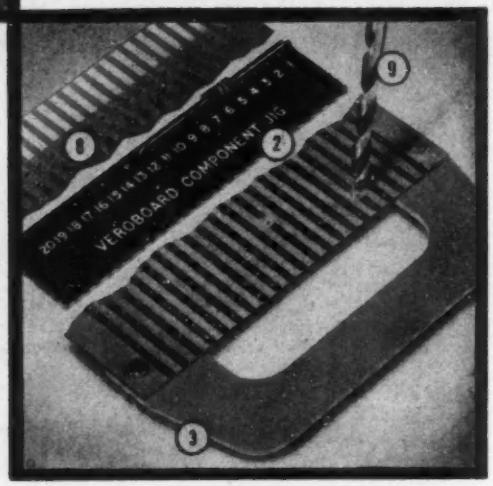
MORGAN BROTHERS (PUBLISHERS) LIMITED
at 28, Essex Street, Strand, London, W.C.2.
Telephone: CENtral 6565 Telegrams: 'Lectroning, Estrand, London'
Annual Subscription: Home and Overseas £1.16.0 post free, Canada and U.S.A. $5.

EE 35 005 *for further details*

Fast, simple, low-cost circuit assembly



with **vero board accessories**



VEROBOARD is the universal wiring board that combines all merits of the printed circuit technique—*without the expense!* Simplicity, speed, cheapness, and reliability are the direct results of the VEROBOARD principle: standard pitching of standard-size holes on a resin-bonded laminate board backed by bonded copper continuity strips.
The following assembly aids and accessories are offered to speed and simplify the assembly of VEROBOARD circuits even further; and to provide even better service in use.

1 **Numeral tape** (self-adhesive) for fast, accurate reference to positions on VEROBOARD. 1–90 for 18″ boards and 1–30 for boards up to 6″. Part Nos. VB3021 and VB3022

2 **Component Jig** for bending wire terminations accurately to fit VEROBOARD matrix. Part No. VB 3031

3 **Plastic Handles** for plug-in VEROBOARD card circuits. Part Nos. VB3051 (black) and VB3052 (red)

4 **Jumper Links** of tinned copper wire for cross connections between bonded copper backing strips on VEROBOARD. Part Nos. VB3061 (0·2″) and VB3062 (0·4″)

5 **Semiconductor Holders** for mounting transistors, etc. with plug-in contacts on 0·2″ matrix. Part No. VB2011 and VB2012

6 **Valveholder Templates** for drilling holes at correct pitch and location on VEROBOARD. Part Nos. VB3041, VB3042 and VB3043

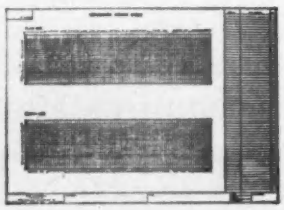
7 **Extruded Edging** in light alloy for strengthening VEROBOARD panels. Part No. VB3091

8 **Plug-in Panels**: 4·8″ × 5·8″ VEROBOARD, gold-plated at one end for use with edge connectors. Part No. VB2001

9 **Spotface Cutter** to make a clean separation where necessary in copper backing strip. Part No. VB3011

10 **Design Sheets** on high quality tracing paper for designing circuits on VEROBOARD and for producing workshop prints. Part Nos. VB3071 (18″) and VB3072 (6″)

11 **Varicon Connectors** which can be used as single point contacts or in rows to form connections between VEROBOARDS. Available in strips of 20. Part No. VB3081 (in line and VB3082 (right angle).



vero board

Notching Tool for Extruded Edging to enable it to be mitred for making corners and for slotting to take VEROBOARD panels. Part Nos. VB3101 Press, VB3102 Mitre die set, VB3103 Slotting die set.

VEROBOARD Kit contains supply of VEROBOARD and accessories.

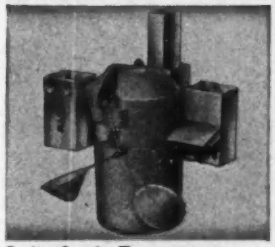
is a product of VERO Precision Engineering Ltd., South Mill Road, Southampton. Telephone: 71061/4

EE 35 006 *for further details*

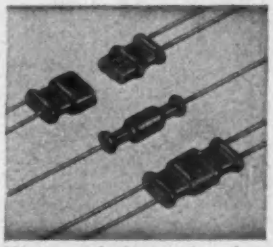
Radio Sonde and electronic equipment

The items shown here are representative of the extensive variety of products manufactured by the Whiteley organisation. Our technical resources are available for the development and production of specialised components for the electronic industry.

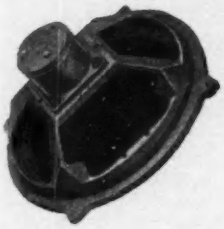
See us at the SBAC Show



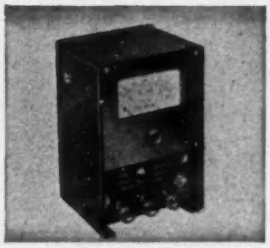
Radio Sonde Transmitter, supplied to British meteorological Office and foreign governments.



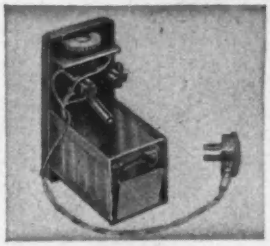
Waterproof plugs and sockets moulded in Polythene for underwater or outdoor installation.



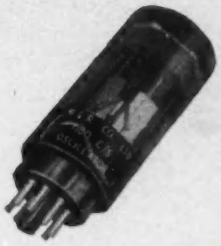
Stentorian Cambric Cone Units, recognised throughout the world as the greatest value in High Fidelity.



The Post Office Tester is a multi-range meter used for making tests on subscribers' apparatus and lines.



Potted components and assemblies in epoxy, Polyester resins and Polythene.



This fixed frequency oscillator is constructed on a standard octal base and encapsulated in epoxy resin.

WHITELEY ELECTRICAL RADIO CO. LTD • Mansfield • Notts

WA/15

ACCURACY TO ± 0·01%

type S1

PRECISION WIREWOUND RESISTOR

Due to the acquisition of high value standard resistors ALMA can now offer on their Type S1. and L2 accuracies of ±0.01% over the range 100 ohms to 1 Megohm. Long term stability is commensurate with such high accuracy.

		Type S1	Type L2
Rating		1 Watt de-rated to ¼ Watt for ± 0.01%	2 Watts
Dimensions	Length	1⅛"	2¼"
	Diameter	13/16"	⅝"
Temperature Coefficient		±0.002% per°C	
Range of Values		100Ω to 1 MΩ	100Ω to 1 MΩ
Tolerance		±0.01%	±0.01%

Full technical data available from:
Diss, Norfolk
Tel: Diss 2288

London Office:
551, Holloway Road, London, N19
Tel: ARChway 0014

Alma

COMPONENTS LTD.

EE 35 007 *for further details*

A new tool for the semiconductor industry...

NEC'S INFRARED MICROSCOPE

There has been no device for viewing stress and impurities in silicon crystals. Now NEC's development of the infrared microscope effectively fills this need.

The microscope uses an NEC image tube rated at 1.3 microns, the most sensitive commercially available. When using the 40x objective and 15x ocular lenses, IR magnification is 1,080x.

Solid state applications are inspection of silicon crystals and other intermetalic compounds for stress and impurities. Other applications are in biological and medical research.

INFRONICS at NEC

Since 1954, NEC has been concentrating on industrial applications of infrared energy and is among the leading producers of devices utilizing infrared. In addition to the microscope these include optical pyrometers, night viewers, and a pupiloscope. This year NEC will demonstrate developments in IR communications.

PERFORMANCE

Electrical
Input voltage: 100-115 v. 50 or 60 c/s
Power consumption: 70 watts

Optics
Visible image: 20x to 1,500x
IR image: Naked eye, 40x to 1,080x
Photographic film, 4.3x to 120x

Wavelengths
Visible: 0.4 μ to 0.76 μ
IR: 0.76 μ to 1.3 μ (with filter)

Dimensions (mm.)
Width length height
700 x 180 x 400
Weight: 23 kg.

NEC *Nippon Electric Company Limited.*

Systems / Components

P.O. Box 1, Takanawa, Tokyo, Japan

ZENITH

Photographs by courtesy of The General Electric Company Ltd.

Street Lighting

When engineers at the General Electric Company Ltd., Shaw, designed their auto-pumping and filling equipment, they relied on *VARIAC continuously-adjustable transformers for stepless regulation.

The plant illustrated is used in the final stages of sodium lamp manufacture, automatically cycling the pumping, baking and filling.

Whenever a stepless A.C. control is needed a VARIAC is usually available from our range of over 300 models. For normal single or three-phase supplies ratings up to 25.2 kVA are standard designs, but other special ganged assemblies can be offered for heavier duties.

VARIACS are compact in design, relatively light in weight and have the exclusive *DURATRAK contact surface to resist oxidation and permit initial surges up to ten times the rated current.

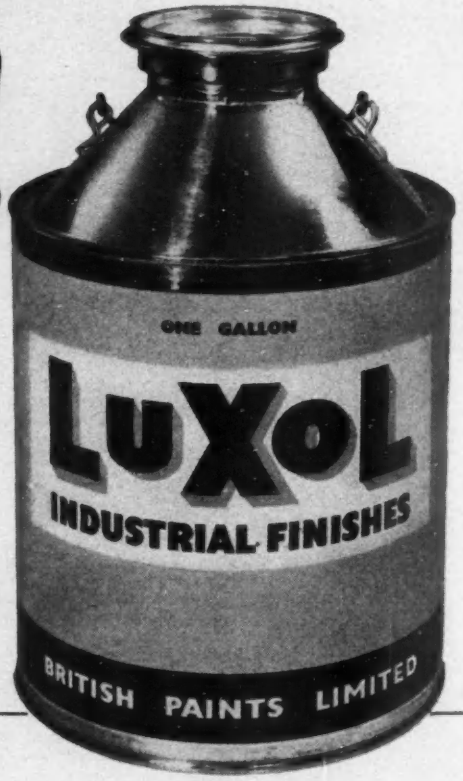
OUR CATALOGUE IS AVAILABLE ON REQUEST.

***Registered Trade Mark**

THE ZENITH ELECTRIC COMPANY LIMITED
ZENITH WORKS · VILLIERS ROAD · WILLESDEN GREEN · LONDON N.W.2
Telephone: WILLESDEN 6581/5 Telegrams: "VOLTAOHM, NORPHONE, LONDON"

EE 35 010 *for further details*

They're sold on LUXOL!



LUXOL INDUSTRIAL FINISHES are specially formulated to give maximum sales-appeal and years of resistance to hard wear. Covering the widest possible range of products, the standard range of 21 Luxol Finishes will provide the perfect answer to your problem.

For sales appeal from start to finish

LUXOL

INDUSTRIAL FINISHES

If you have a really out-of-the-ordinary painting problem consult our Technical Advisory Service. If necessary they will prepare a special paint to meet your requirements exactly.

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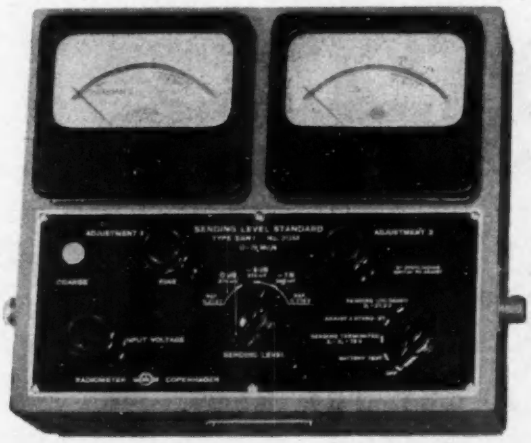
NORTHUMBERLAND HOUSE, 303-306 HIGH HOLBORN, LONDON, W.C.1
MERSEY PAINT WORKS, WAPPING, LIVERPOOL
Belfast · Birmingham · Bristol · Cardiff · Glasgow · Leeds · Manchester · Norwich · Plymouth · Sheffield · Southampton · Swansea and all principal towns.

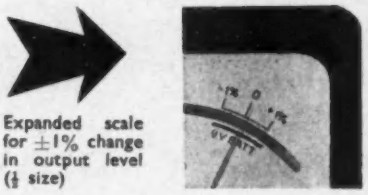
1754

For Accurate Calibration of Level Meters

SENDING LEVEL STANDARD

Type SNN1





Expanded scale for ±1% change in output level (½ size)

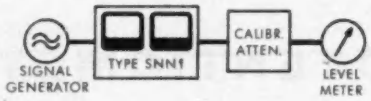
D-C to 15 Mc

ACCURATE

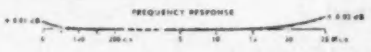
RMS-READING

EASY TO OPERATE

The Sending Level Standard is a high-precision instrument for accurate calibration of level meters and measurement of their frequency responses.



Typical set-up for calibration of a level meter at low levels. Accurate measurement of the level meter frequency response is conveniently made by keeping the level meter indication constant and using the incremental facility of the Type SNN1 to read small variations in the output level.



Output Levels

0 dB/0.274 V=274 mV
−9 dB/0.775 V=275 mV
−1 N/0.775 V=285 mV
across a 75 ohm load or open-circuit.

Output impedance

75 and 37.5 ohms depending on the mode of operation.

Input Impedance

75 ohms

Accuracy

0.5% from 1 kc to 1 Mc
1% at d-c and from 10 cps to 15 Mc.
1% accuracy up to 25Mc with 75 ohm termination

Battery operated

RMS-Reading

Overload protected

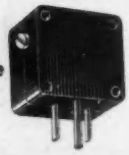
Write for complete information

RADIOMETER
72 Emdrupvej, Copenhagen NV, Denmark

Represented in Great Britain by

Livingston Laboratories Ltd.
31 Camden Road, London, N.W.1

this illustration is actual size



SOME FACTS ABOUT THE NEW

RIVLIN

miniature

PRECISION PRE-SET POTENTIOMETER

its precision worm drive assures smooth adjustment without backlash ● its setting remains stable under vibration and shock ● its ratchet mechanism prevents overwinding ● it occupies only 0.11 cu. in. ● can be mounted vertically, in tandem side by side or stacked ● it is specifically designed for today's advanced electronic techniques ● conforms to BSI 3081

and here is its brief specification:

Resistance Range ...	...	10 Ω to 10k Ω
Tolerance	...	±10%
Rating	...	1w at 20°C, ½w at 70°C
Temperature Range	...	−40 to +70°C Ambient
Weight	...	0.1 oz.
Temp.: Co-eff. ...	...	Less than 20 p.p.m.
Mechanical Life ...	...	500 cycles (Slider).

ril

RIVLIN INSTRUMENTS LIMITED

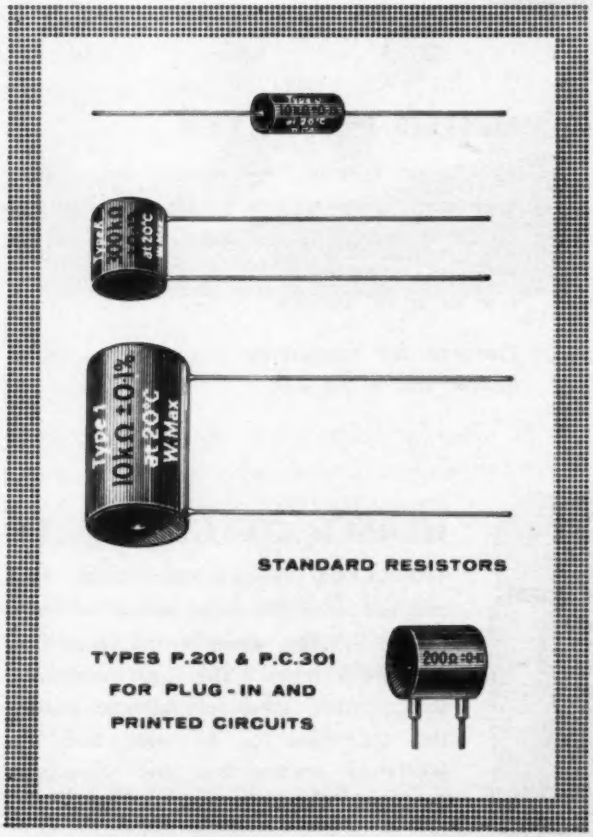
Doman Road, Camberley, Surrey. Tel: Camberley 2507/8

Grams: Rivelectron, Camberley. LONDON OFFICE. Tel: Swiss Cottage 3038

GD373

Even higher quality in **quantity!** through advanced techniques and extended capacity...

RIVLIN
precision wirewound resistors



STANDARD RESISTORS

TYPES P.201 & P.C.301
FOR PLUG-IN AND
PRINTED CIRCUITS

NEW ENCAPSULATION METHOD

Rivlin Instruments Limited have developed a new method of encapsulation, based on epoxy resin, which has the following advantages:—

Wide Temperature Range—Proof against High Humidity. Suitable for use in the temperature range -55°C to +120°C with or without humidity, without significant effect on accuracy and stability.

Improved Stability. The new method results in resistors having stability of a very high order.

Interchangeability. The new range is completely interchangeable with the existing RIL types (1-9) and all dimensions are exact and repeatable within close limits.

Precious Metal Plated Terminations. In accordance with the best modern practice, the terminations are gold plated for ease of soldering and to prevent oxidation during storage.

STANDARD RANGE

Rating ¼W to 3W. Range −1Ω to 3MΩ tolerance to ±0.1% of nominal value or 0.01Ω whichever is the greater. Terminals, wire leads or solder lugs, fixing studs can be fitted.

PLUG-IN

Rating ¼W (other ratings to order). Range 50Ω to 200KΩ, tolerance ±0.1%. Designed for rapid range changing in recorders, computing networks, voltage dividers, etc. Phosphor bronze pins, gold plated for low contact resistance, plug into Electro Methods type D2 socket (special spacings to order).

PRINTED CIRCUIT

Rating ¼W (other ratings to order), range 50Ω to 200KΩ, tolerance ±0.1%. Designed specifically for Printed Circuit use with Phosphor Bronze pins, silver finished, spaced to suit standard Printed Circuit module.

NEW PRODUCTION CAPACITY

By the recent completion of additional factory, laboratory and office buildings our capacity and scope have literally tripled. Delivery is now 3 to 6 weeks according to size of order. Where high accuracy and consistent performance are vital considerations then RIVLIN is the resistor to specify.

ril

Full technical data available on request.

RIVLIN INSTRUMENTS LIMITED
Yorktown Industrial Estate, Doman Road, Camberley, Surrey
Tel: Camberley 2507/8 Grams: Rivlectron Camberley London Office. Tel: Swiss Cottage 3038

GD 637

EE 35 014 *for further details*

OXYGEN REMOVAL and MEASUREMENT

For the removal of oxygen from other gases

DEOXO CATALYTIC GAS PURIFICATION PROCESS

The model 'D' Deoxo Purifier, which operates at room temperature, provides for the removal of oxygen or hydrogen from other gases such as argon, helium, nitrogen, etc., with a remaining impurity of less than 1 ppm. These Purifiers are available in a number of standard sizes for gas flows from 5 scfh to 10,000 scfh.

Additional units are available for the removal of other impurities from a wide range of industrial gases.

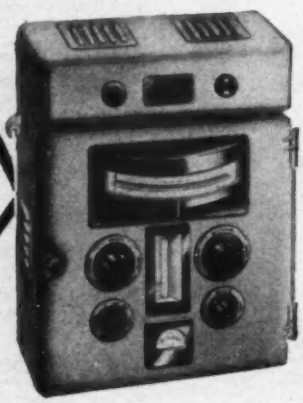
For pure dry hydrogen

DEOXO PURIDRYER

The Deoxo Puridryer will remove oxygen from hydrogen to leave less than 1 ppm of the impurity remaining, and subsequently dry the purified gas to a dew point as low as minus 100° F, at flow rates of up to 100 scfh.

Provision for regenerating the drying agent is incorporated in the unit.

For continuous measurement of oxygen



HERSCH OXYGEN METER

The Hersch Oxygen Meter has been designed for the measurement of trace oxygen in other gases in the range 0-10 and 0-100 ppm. The high sensitivity, accuracy and speed of response enables this instrument to be used both for laboratory investigation and production quality control.

★ *Illustrated literature available on request.*

ENGELHARD INDUSTRIES LTD BAKER PLATINUM DIVISION

52 HIGH HOLBORN . LONDON . W.C.1 . *Telephone; CHAncery* 9050

EE 35 015 *for further details*

CIRCUIT MAGNIFICATION METERS

INDUCTANCE CAPACITANCE

★ **Direct reading of 'Q' Range 10-400**
★ **Frequency Range 100 kc/s - 100 Mc/s**
★ **Rapid calculation of 'L' and 'Z' by scales incorporated**
★ **'Q' Comparison**
★ **'% Q' Range ± 10%**
★ **No 'Set Zero' problem**

The 'Q' Meter Model T2 is a reliable instrument for making measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The variable-capacitor control has three calibrated scales which greatly simplify the calculations of inductance and impedance. A comparison facility is incorporated to enable batch testing by unskilled personnel.

Model T2 net price in U.K. **£90**

Full technical details of Leaflet No. M44

by

Advance

– to be sure!

STANDARD INDUCTORS. TYPE LSI

Consisting of 12 coil units covering inductances from 0.1 μH to 30 mH for use with the Advance 'Q' meters. Individually calibrated, these coils are 'standards' for the laboratory.
Set of 12 Inductors in carrying case **£55 0s. 0d.** net price in U.K.

Full technical details in Leaflet No. M55

Advance COMPONENTS LIMITED
INSTRUMENTS DIVISION
ROEBUCK ROAD • HAINAULT • ILFORD • ESSEX • TELEPHONE : HAINAULT 4444

ITGD72

EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

EE 35 014 *for further details*

OXYGEN REMOVAL and MEASUREMENT

For the removal of oxygen from other gases

DEOXO CATALYTIC GAS PURIFICATION PROCESS

The model 'D' Deoxo Purifier, which operates at room temperature, provides for the removal of oxygen or hydrogen from other gases such as argon, helium, nitrogen, etc., with a remaining impurity of less than 1 ppm. These Purifiers are available in a number of standard sizes for gas flows from 5 scfh to 10,000 scfh.

Additional units are available for the removal of other impurities from a wide range of industrial gases.

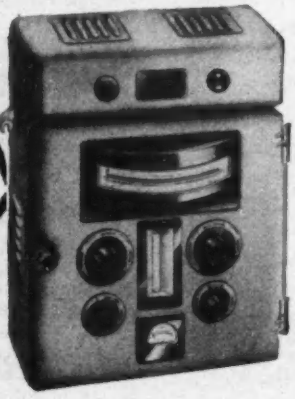
For pure dry hydrogen

DEOXO PURIDRYER

The Deoxo Puridryer will remove oxygen from hydrogen to leave less than 1 ppm of the impurity remaining, and subsequently dry the purified gas to a dew point as low as minus 100° F, at flow rates of up to 100 scfh.

Provision for regenerating the drying agent is incorporated in the unit.

For continuous measurement of oxygen



HERSCH OXYGEN METER

The Hersch Oxygen Meter has been designed for the measurement of trace oxygen in other gases in the range 0-10 and 0-100 ppm. The high sensitivity, accuracy and speed of response enables this instrument to be used both for laboratory investigation and production quality control.

★ *Illustrated literature available on request.*

ENGELHARD INDUSTRIES LTD BAKER PLATINUM DIVISION

52 HIGH HOLBORN . LONDON . W.C.1 . *Telephone; CHAncery* 9050

EE 35 015 *for further details*

CIRCUIT MAGNIFICATION METERS

INDUCTANCE CAPACITANCE

★ **Direct reading of 'Q' Range 10-400**
★ **Frequency Range 100 kc/s - 100 Mc/s**
★ **Rapid calculation of 'L' and 'Z' by scales incorporated**
★ **'Q' Comparison**
★ **'%Q' Range ± 10%**
★ **No 'Set Zero' problem**

The 'Q' Meter Model T2 is a reliable instrument for making measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The variable-capacitor control has three calibrated scales which greatly simplify the calculations of inductance and impedance. A comparison facility is incorporated to enable batch testing by unskilled personnel.

Model T2 net price in U.K. **£90**

Full technical details of Leaflet No. M44

by

Advance

– to be sure!

STANDARD INDUCTORS. TYPE LSI

Consisting of 12 coil units covering inductances from 0.1 μH to 30 mH for use with the Advance 'Q' meters. Individually calibrated, these coils are 'standards' for the laboratory.
Set of 12 Inductors in carrying case **£55 0s. 0d.** net price in U.K.

Full technical details in Leaflet No. M55

Advance COMPONENTS LIMITED
INSTRUMENTS DIVISION
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ITGD72

EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

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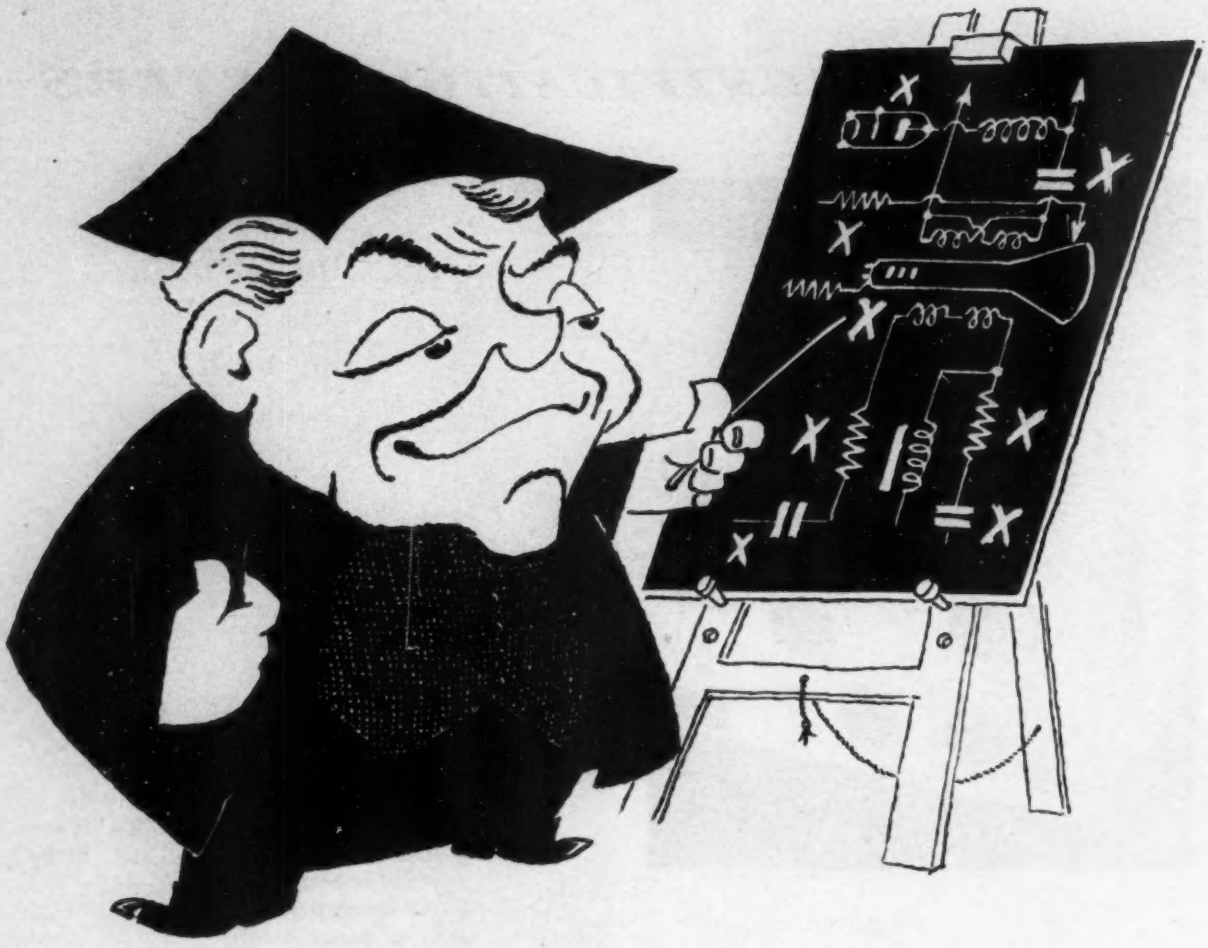

Wherever

a conductive coating is indicated —

Wherever you need an electrically conductive coating, use one of the Foliac Colloidal Graphite Dispersions. You can spray them or brush them, inside or out, to provide high resistance paths, low resistance paths, capacitor effects, screening or 'earth'. From C.R. tubes and thermionic valves to simple resistor contacts . . . name the use of a conductive coating and the answer is 'Foliac'. If you have a problem involving a conductive film, remember Foliac research is at your service. Why not ask our representative to call?

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COLLOIDAL GRAPHITE DISPERSIONS

GRAPHITE PRODUCTS LIMITED
A Member of The Morgan Crucible Group

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GP.103/333

AEI focus on...

GERMANIUM GOLD-BONDED DIODES

For COMPUTERS, DATA PROCESSING and INSTRUMENTATION APPLICATIONS and for GENERAL LOW-POWER RECTIFICATION where high efficiency is required

ADVANCE INFORMATION

OUTSTANDING FEATURES * LOW FORWARD RESISTANCE HENCE HIGH EFFICIENCY WIDE RANGE OF P.I.V. AVAILABLE * SUB-MINIATURE ALL-GLASS CONSTRUCTION * HERMETIC SEAL

FAST GOLD-BONDED DIODE—Type CG84H

Max. Peak Inverse Voltage:	12 volts
Max. Forward Voltage drop at 40 mA, 25°C:	0.6 volts
Max. Inverse Current at -12V, 25°C:	12 microamperes
at -12V, 60°C:	38 microamperes
Max. Mean Forward Current at 25°C:	90 milliamperes
Max. Junction Capacitance at -1V:	2.4 picofarads
Max. Stored Charge at -10V inverse, 10mA forward and 100 ohms circuit impedance:	0.6 milli-micro-coulombs

STANDARD GOLD-BONDED DIODES—
Types CG80H, CG81H, CG82H, CG83H and CG85H

Maximum Ratings

at 25°C ambient temperature	CG80H	CG81H	CG82H	CG83H	CG85H
Peak inverse voltage V	100	75	50	25	12
Mean forward current mA	70	75	77	80	90
Load (averaged over any 20 ms period) mW	100	110	110	110	114

Forward Characteristics

at 25°C ambient temperature		CG80H to CG83H		
Forward current	mA	10	30	100
Voltage drop. Typical	V	0.375	0.50	0.8
Maximum	V	0.45	0.65	1.1

		CG85H
Forward current	mA	40
Voltage drop. Maximum	V	0.6

Inverse Characteristics		CG80H	CG81H	CG82H	CG83H	CG85H
at P.I.V.	V	100	75	50	25	12
Typical inverse current at 25°C	μA	30	38	20	12	—
at 60°C	μA	150	180	120	75	—
Maximum inverse current at 25°C	μA	100	75	50	25	12
at 60°C	μA	500	300	250	150	38

Capacitance Typical production spreads measured at -1 volt are as follows: Minimum 1.1 pF; Typical 1.8 pF; Maximum 3.0 pF.

Hole Storage When measured with 10 mA forward current, 10 volts inverse voltage and 100 ohms circuit impedance hole storage values are as follows: Typical 1.0 mμC; Maximum 3.0 mμC.

PLEASE DON'T TEAR OUT THIS ADVERTISEMENT— others will want to see it . . . If you would like to receive full details of these or any other AEI electronic components, all you have to do is write to AEI at the address below. Data sheets with detailed information will be sent to you without charge.

HELP YOURSELF *Make sure your name is on our mailing list to receive advance information on all new AEI components.* Don't delay—write NOW!

FEATURES—

common to all types (CG80H to CG85H)

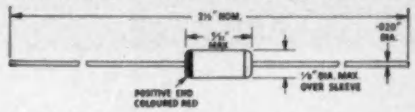
ENCAPSULATION All these AEI Gold-bonded Diodes are of all-glass construction with lead-in wires sealed into the encapsulating tube. The expansion of the wire is matched to that of the glass, providing a hermetic glass-to-metal seal over a wide range of ambient temperatures. The junction is thus fully protected and the characteristics of the diode are very stable because no fluxes, varnishes or other harmful internal contaminants are used.

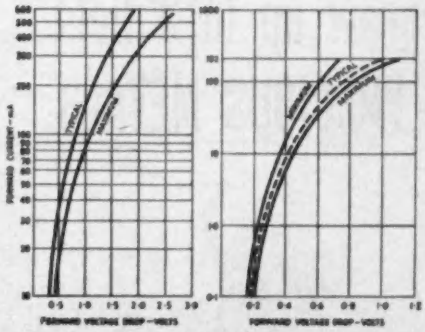
SHOCK-RESISTANCE Because of their small size (about ¼ in. diameter and ¼ in. long), and the rigidity of the small component assemblies, these diodes are able to withstand severe mechanical vibration and shock.

SILVER-PLATED LEADS The lead-in wires are silver-plated to facilitate soldering, but a thermal shunt should be used if heat is applied close to the diode body. In any case, joints should not be made closer than ¼ in. to the diode body and the leads should not be bent closer than 1/16 in.

IDENTIFICATION Normally each type of diode is identified by a plastic sleeve and the polarity is shown by marking the cathode end of the body red.

DIMENSIONS—Similar for all types.





Forward characteristic CG80H to CG83H

Forward characteristic CG84H to CG85H

AEI Associated Electrical Industries Limited

ELECTRONIC APPARATUS DIVISION VALVE & SEMI-CONDUCTOR SALES DEPT
CARHOLME ROAD, LINCOLN. TEL: LINCOLN 26435

A 9684

GERMANIUM GOLD-BONDED DIODES

We grew up in a field of PRECIOUS METALS

Entering our third century, we can rightly claim to know an awful lot about this precious industry of ours. "Resting on our Laurels", however, is not for us—we prefer to think of laurels as repeat orders . . . our repeat orders have come by the hard way—by the continuous service we have maintained through two whole centuries to the Precious Metal Industry—and that is a long time . . . If you can use our experience, skill, and service, for silver solders, brazing alloys, electrical contacts and contact materials, or precious metals in any form, give us a call—you'll find we are 'old hands at the game'.

The **SHEFFIELD SMELTING**
COMPANY LIMITED

HEAD OFFICE AND WORKS: ROYDS MILL STREET, SHEFFIELD, 4.
ALSO AT LONDON AND BIRMINGHAM.

RMS PEAK AVERAGE INDICATION

in terms of db VOLTS dbm

Electronic Voltmeter Type (2409) features:

- **Peak, arithmetic average, and true R.M.S. measurements** by means of specially designed rectifier circuits. The accuracy of the R.M.S. indication is better than 0.5 db for signals with crest factors up to 5.
- **Linear frequency response (to within ±0.2 db) from 2 c/s to 200,000 c/s.** Input impedance 10 MΩ in parallel with 20$\mu\mu$F. To facilitate the use of the instrument as **a calibrated amplifier** it is supplied with screened output terminals. Output impedance: Approximately 50 Ω.
- **Illuminated meter scale calibrated in volts, db with reference to 1 volt and dbm (1 mV into 600Ω).** Sensitivity variable in 10 db-steps from 10 mV to 1000 V full scale deflection.
- **Two different meter damping characteristics,** one of which is in accordance with the standards for VU-measurements, and the other a high damping suitable for measurements of low frequency signals.

Write or phone for further information.

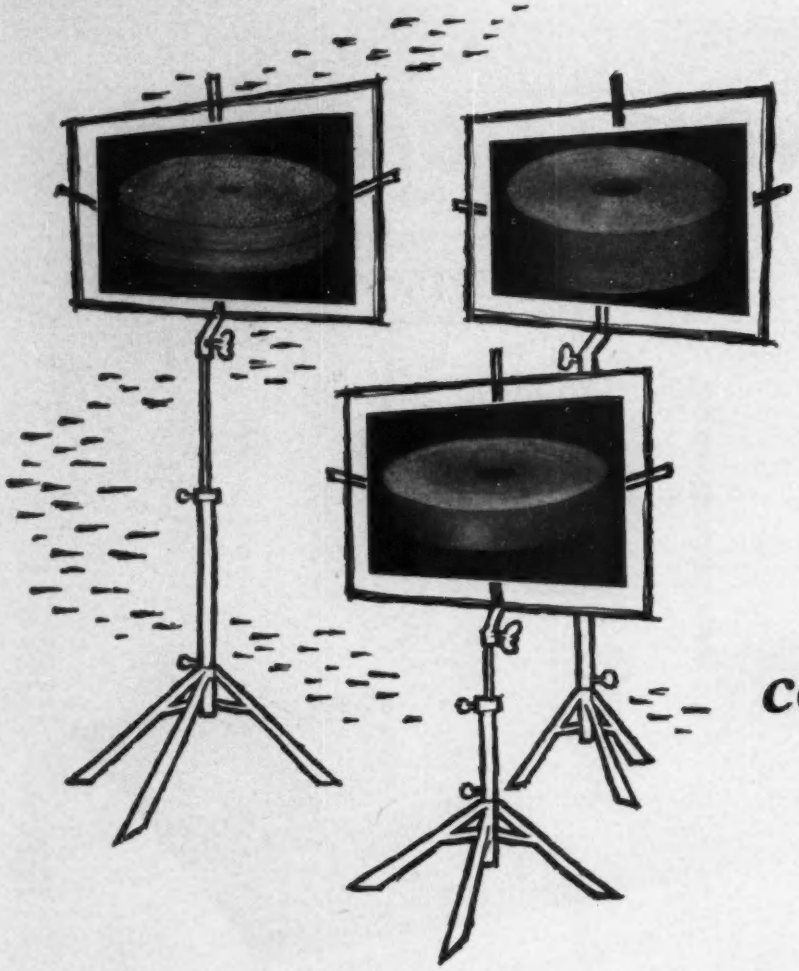
Ask for demonstration

LONDON, W.1. 4 Tilney Street, Park Lane

B K **Brüel & Kjær**

Tel: GROsvenor 4567 . Cables: BANKLABS LONDON

EE 35 020 *for further details*



Trio for conductors

Three types of tape designed to cover all electrical insulation work from class B upwards. Send now for further information quoting ref: HSA/241.

PYROFLEX 1 Regd.

Pyroflex Asbestos Listing Tape has been specially designed for the electrical industry. It is manufactured from carefully selected and purified fibres and has a wide application for Class B insulation.

DURAGLAS 2 Regd.

Duraglas glass-fibre tapes have many applications within the electrical insulation field such as conductor insulation, coil wrappings, core bindings, mechanical reinforcements, cable wrappings, and heat resistant protective coverings.

p.t.f.e. 3

p.t.f.e. has exceptionally good dielectric properties, is non-cracking, non-flammable, resistant to moisture and totally unaffected by weathering conditions. As a result it has a wide application in the electrical industry in the form of tape for the insulation of cables, motors and transformers.

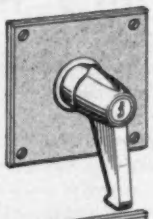
COVERING ALL INSULATION REQUIREMENTS

TURNERS

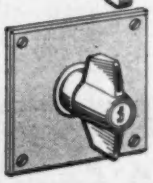
TURNER BROTHERS ASBESTOS CO. LTD · ROCHDALE · ENGLAND

A MEMBER OF THE TURNER & NEWALL ORGANISATION

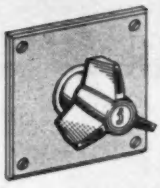
TA241



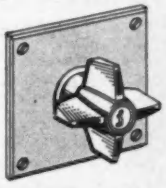
PISTOL GRIP



SPADE



STAR

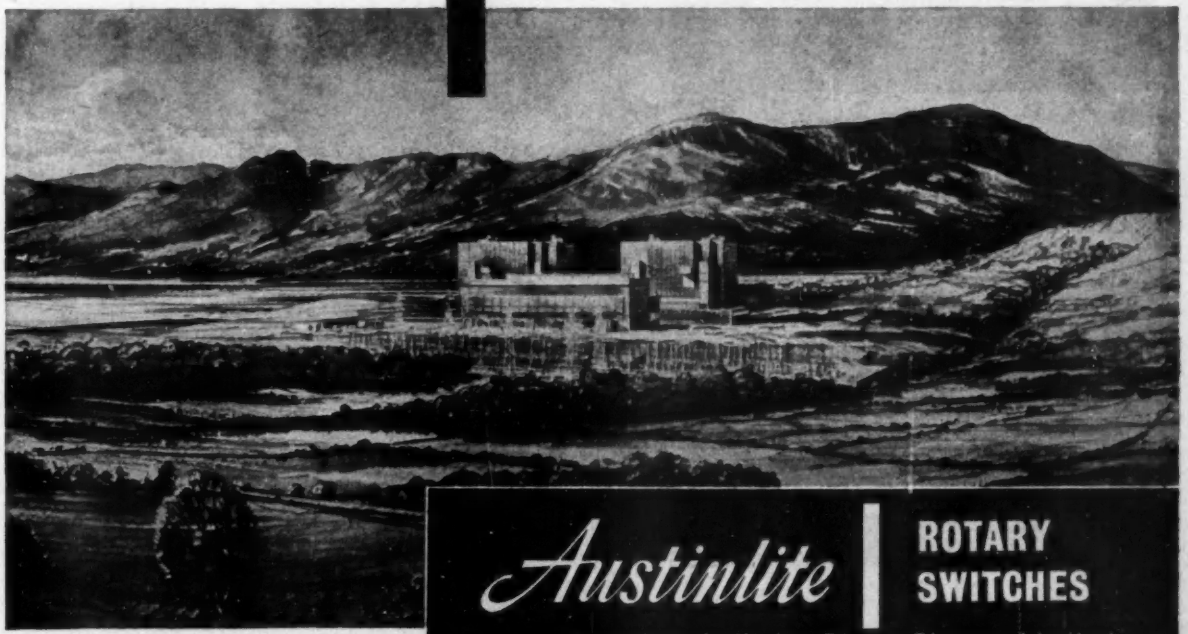


CRUCIFORM

These new shapes are now available to all users

Trawsfynydd, the latest of Britain's nuclear power stations, will incorporate more than 2,500 Austinlite rotary control switches. They are designed to meet the exacting requirements of the Central Electricity Generating Board and of the main contractors, Atomic Power Constructions Limited.

Modern power station practice demands that switch duties be identified by the shape of the operating handle. To meet this requirement Austinlite produced these special designs.



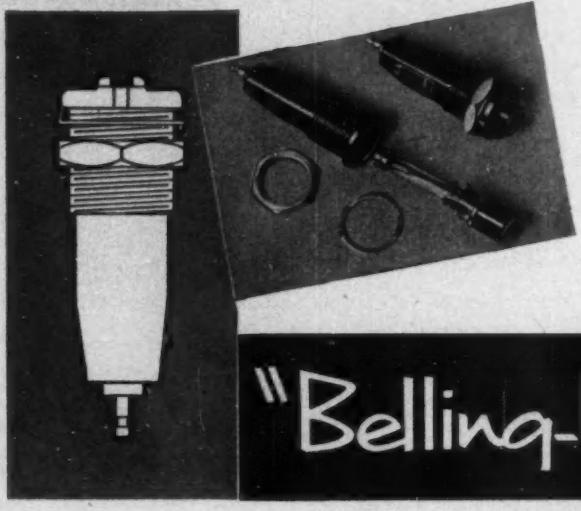
(Artist's impression of Trawsfynydd by courtesy of C.E.G.B.)

Austinlite | ROTARY SWITCHES

• custom-built by Stone-Chance Limited

ENQUIRIES: To help us to give prompt service, enquiries should now be addressed to Austinlite Ltd., Pickersleigh Road, Malvern Worcs., or to the London Office :- Schomberg House, 82 Pall Mall, S.W.1.

EE 35 022 *for further details*

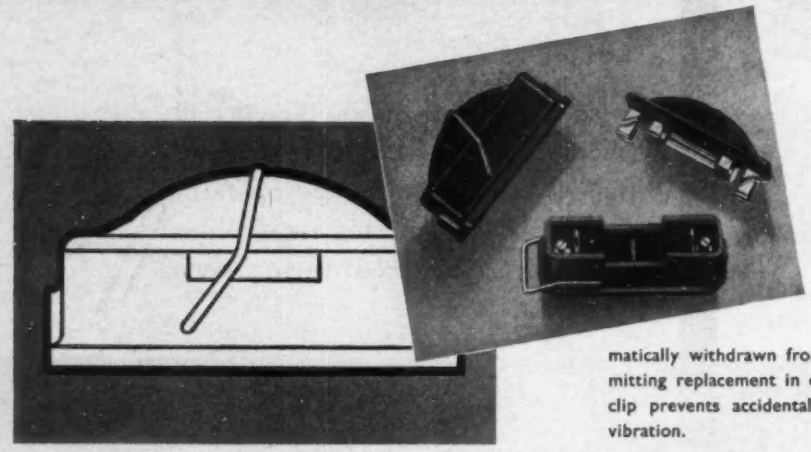


L.1348. STANDARD PANEL FUSE-HOLDER, SIZE O—TYPE APPROVED

This compact fuseholder has become virtually one of the standards of industry since it was first introduced nearly 23 years ago. Certain detailed improvements have been made over the years, chief of which is the change to a higher grade of moulding powder which has enabled it to retain Services' Type Approval in the face of the more stringent requirements of the present day specification, R.C.S. 262. Max. working volts, 250 V. a.c.; current rating, 5 amp.

GENERAL PURPOSE

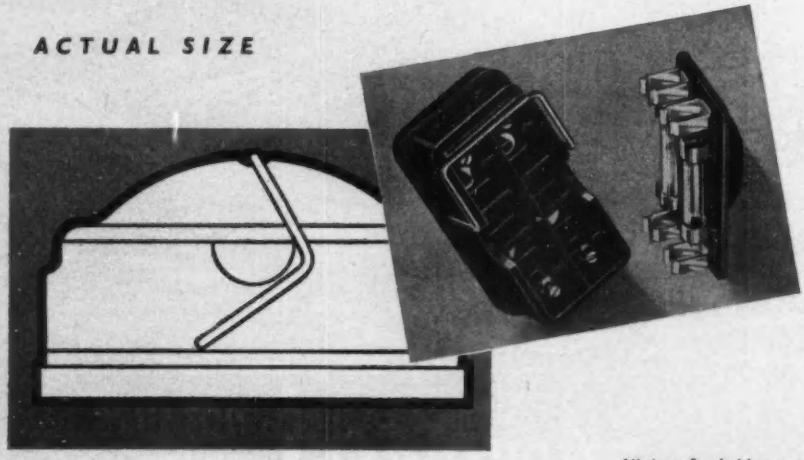
"Belling-Lee" FUSEHOLDERS & FUSEBOXES



L.1045/C3. SINGLE SAFETY FUSEBOX SIZE O

A single pole fusebox for chassis or panel mounting, with facilities for end or rear wiring. The fuse-link is carried in the lid, and is therefore exposed and automatically withdrawn from circuit as the lid is raised, permitting replacement in complete safety. A spring retaining clip prevents accidental disengagement of the lid under vibration.

ACTUAL SIZE



L.1033/C4. TWIN SAFETY FUSEBOX SIZE O

This is the double pole version of the above fusebox, and incorporates identical design features. The maximum recommended working voltage for both types is 250 V. a.c., and the current rating is 10 amp. per pole.

All these fuseholders accommodate 1¼" x ¼" cartridge fuse links, such as types L338, L693, L762, L1055, L1358.

Most "Belling-Lee" products are covered by patents or registered designs, or applications.

Regd.

PLUGS & SOCKETS · GLASS SEALS
TERMINALS · CIRCUIT PROTECTION DEVICES
INTERFERENCE FILTERS · RECEIVING AERIALS

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

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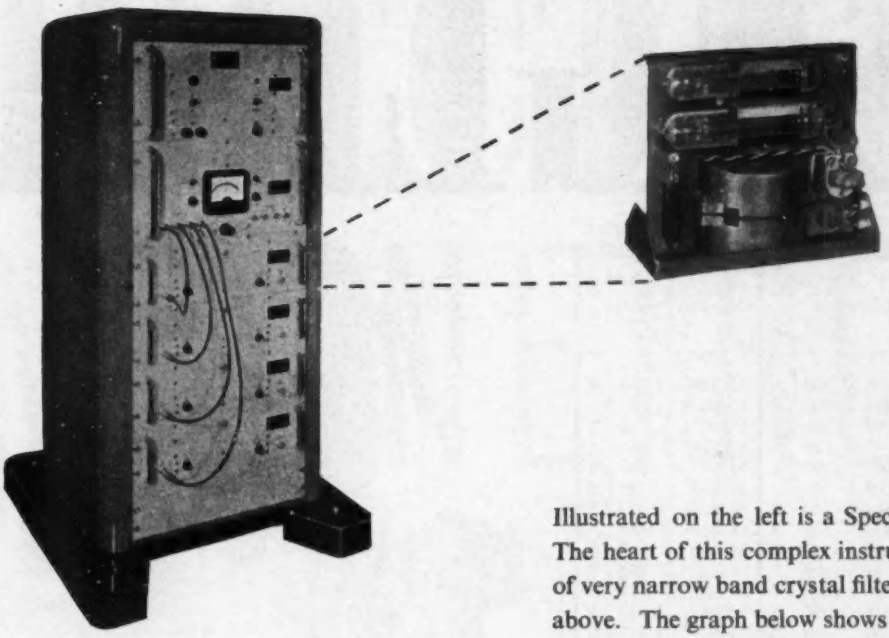
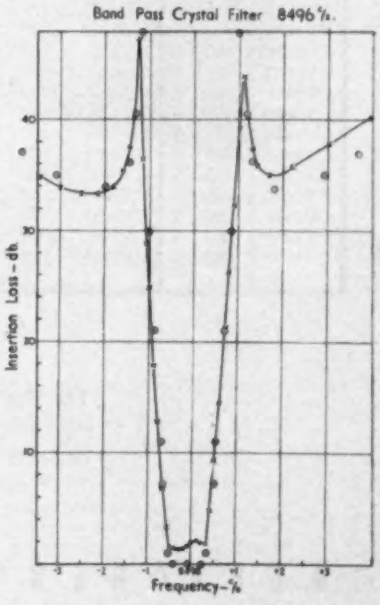


Illustrated on the left is a Spectrum Analyser. The heart of this complex instrument is a bank of very narrow band crystal filters as illustrated above. The graph below shows the response of a typical filter of this type. The instrument also includes d.c. amplifiers of very high stability.

The Spectrum Analyser illustrates the range of equipment which we design and manufacture to special requirements.

ELECTRIC WAVE FILTERS

- ★ Filters designed for band pass, low pass, high pass or band stop characteristics.
- ★ Frequency range is approximately 0-20 Mc/s.
- ★ Filters designed by modern techniques to a given specification.
- ★ Filters for use in multichannel systems.
- ★ Filter amplifiers and active filters for use at low frequencies.



BARR & STROUD LTD.

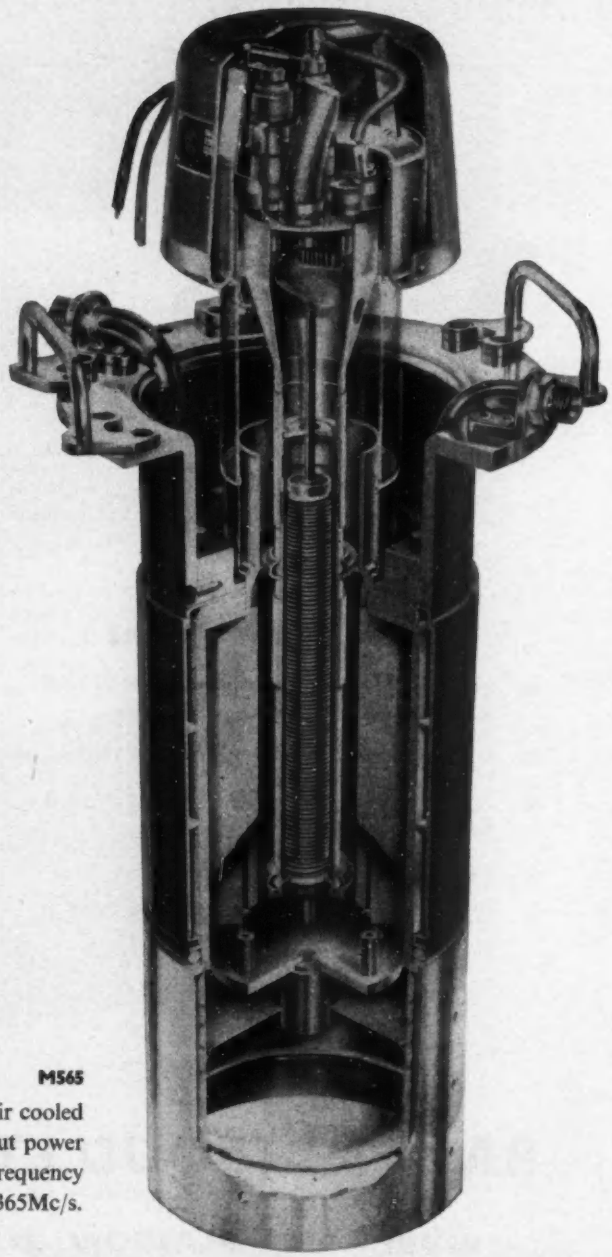
ANNIESLAND, GLASGOW, W.3

London Office: Kinnaird House, 1 Pall Mall East, S.W.1

EE 35 024 for further details

ENGLISH

Magnetron	Typical Peak Output Power (kW)	Freq. Band	Magnetron	Typical Peak Output Power (kW)	Freq. Band	Magnetron	Typical Peak Output Power (kW)	Freq. Band
2J30	300	S	CV1498	200	S	CV3982	50	X
2J31	300	S	CV1499	200	S	CV5018	80	X
2J32	300	S	CV1500	200	S	CV5031	50	X
2J33	300	S	CV1747	45	X	CV5235	45	X
2J34	300	S	CV1807	300	S	M501	500	S
2J42	8	X	CV1808	300	S	M501A	500	S
2J55	45	X	CV1809	300	S	M501B	500	S
2J56	45	X	CV1810	300	S	M502A	180	X
4J31	1000	S	CV1897	1000	S	M503A	8	X
4J32	1000	S	CV1898	1000	S	M504	750	X
4J33	1000	S	CV1914	1000	S	M505	45	X
4J34	1000	S	CV1916	1000	S	M506A	50	X
4J35	1000	S	CV2281	8	X	M507	425	S
4J43	900	S	CV2284	225	X	M508	8	X
4J44	900	S	CV2362	1150	S	M509	8	X
4J50A	225	X	CV2363	1150	S	M513A	18	X
4J52A	80	X	CV2364	1150	S	M519	425	S
4J53	1000	S	CV2365	1150	S	M521	45	X
4J78	250	X	CV2366	1150	S	M523	225	X
5586	1000	S	CV2367	1150	S	M525	1150	S
5657	1000	S	CV2368	1150	S	M528	200	S
6027	20	X	CV2373	180	X	M529	225	X
7182	2500	S	CV2376	45	X	M535	7·2	X
CV370	8	X	CV2412	225	X	M537	8	X
CV513	1000	S	CV2424	225	X	M538A	225	X
CV1475	425	S	CV2425	225	X	M539	225	X
CV1476	425	S	CV2426	225	X	M546	225	X
CV1477	425	S	CV2473	225	X	M547	225	X
CV1478	425	S	CV2744	1000	S	M548	50	X
CV1479	500	S	CV2852	45	X	M549	225	X
CV1480	500	S	CV3528	18	X	M554	2600	L
CV1481	500	S	CV3611	1000	S	M558	8	X
CV1482	500	S	CV3659	500	S	M559	20	X
CV1483	425	S	CV3660	500	S	M561	80	S
CV1484	425	S	CV3661	500	S	M565	5000	L
CV1485	425	S	CV3662	500	S	M566	2500	S
CV1486	425	S	CV3676	8	X	M569	2500	S
CV1495	200	S	CV3953	250	X	M570	2500	S
CV1496	200	S	CV3958	1000	S	M573	2500	S
CV1497	200	S	CV3976	8	X	M574	2500	S



M565

The M565 is a water and forced-air cooled pulse magnetron with a peak output power of 5MW and operates at a fixed frequency within the limits 1215 to 1365Mc/s.

DESIGNED AND MANUFACTURED BY

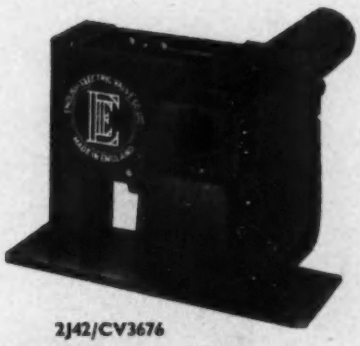
EE 35 025 *for further details*

ELECTRIC MAGNETRONS

from 5MW to 5kW

5586/CV3611

This is a forced-air cooled pulse magnetron with a peak output power of 1MW. It is a tunable version of the 4J31-35 range, covering a frequency band from 2700 to 2900Mc/s.



2J42/CV3676

The 2J42 is a packaged forced-air cooled pulse magnetron with a peak output power of 8kW operating at a fixed frequency within the limits of 9345 to 9405Mc/s.

The range of pulse magnetrons manufactured by the **English Electric Valve Company Limited** *is extensive and includes types for most applications. For comprehensive information on any of our magnetrons please write to the address below.*

ENGLISH ELECTRIC VALVE CO. LTD

Chelmsford, England. Telephone: Chelmsford 3491 | **AGENTS THROUGHOUT THE WORLD**

AP171a

EE 35 026 *for further details*

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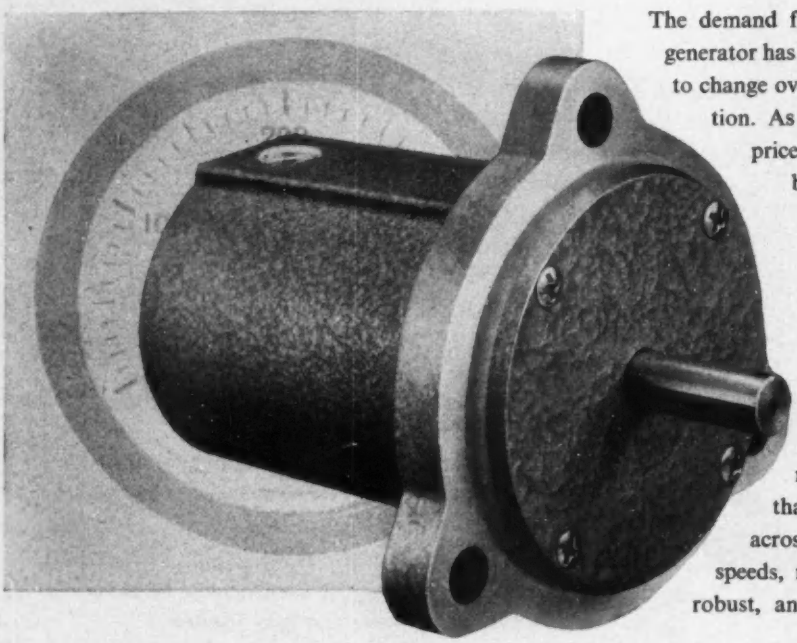
Tachogenerator prices



The demand for the Crompton Parkinson tachogenerator has been so great that it has been possible to change over to more fully mechanised production. As a result we have been able to cut the price of foot and flange mounting models by about 30% and to make substantial reductions in the prices of other types. Some necessary modifications in shape and size have been made, with the result that all models are more compact than before. But the essentials of their design are unchanged. C.P. tachogenerators are still 3-phase A.C. units—with no brushgear or sliding contacts—that provide a steady rectified voltage across the indicator even at very low speeds, run smoothly on a low torque, are robust, and completely reliable.

Crompton Parkinson

CROMPTON PARKINSON LTD., CROMPTON HOUSE, ALDWYCH, LONDON, W.C.2

Dear Sirs,

Don't faint. The humble plight depicted in our Photo didn't really happen. It's just our mate Fred up to his tricks. Candle grease on an old coil produced the alarming 'fire' shown in the photo. Our title is "The day the amplifier stopped oscillating"! For this side-splitter, may I be so bold as to ask double fee? Ten and six shouldn't break you.

Two cheery boys from
Cocklehampton

Dear Cheery Boys,

It isn't the ten and six that breaks us. It's the thought behind it. I suggest you try setting fire to your photographs next time - then we can get on with the job of telling people about our gold-bonded diodes, high frequency transistors and all the other semiconductors we are supplying to manufacturers at a rate of 250 thousand a week. Couldn't you go away ... or something?

"Desperate"
G.E.C.

THE GENERAL ELECTRIC CO LTD SEMICONDUCTOR DIVISION SCHOOL STREET HAZEL GROVE STOCKPORT CHESHIRE

For that special job!

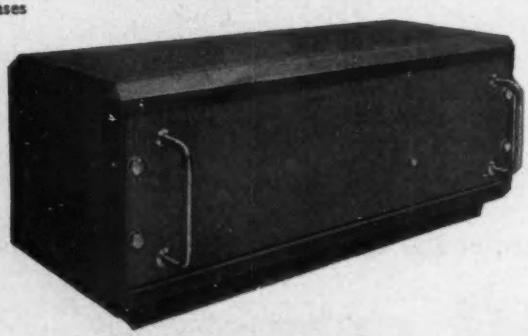
'SL' Desk Type Cases

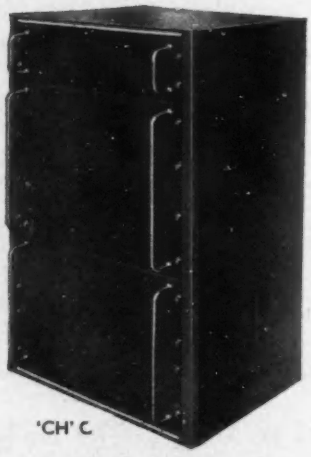
SPECIFY Datum CASES

Designed to perform their function most efficiently, Datum standard instrument cases also present a trim, businesslike appearance. Give your equipment that immediate appeal which brings quick sales.

- ✻ Fabricated from the finest quality zinc-coated steel.
- ✻ Engineered for maximum strength-to-weight ratio.
- ✻ Complete interchangeability ensured by special tooling.
- ✻ Wide choice of panels, chassis and handles.
- ✻ Completely versatile air control arrangements.

'SS' Cases





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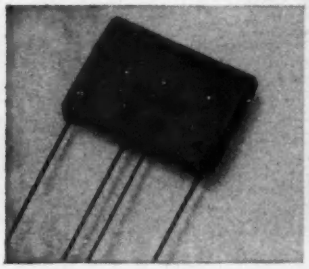
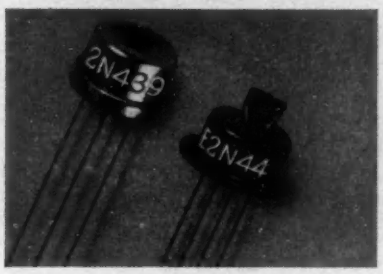
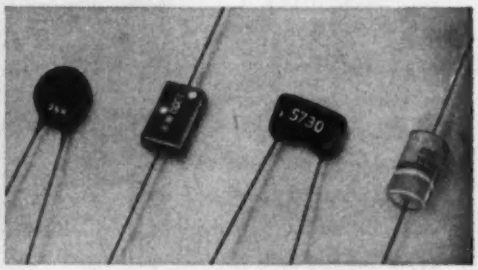
FROM *MARKEM*- EVERYTHING YOU NEED TO MARK ALL OF YOUR PRODUCTS AND PACKAGES

Markem machines are used throughout the world to mark electrical and electronic components of every description —*at production speeds*— with clear, durable imprints. Machines ranging from the small, hand-operated "Companion" to completely automatic high speed types are capable of handling products and packages of almost any size and shape. Printing elements are available for marking almost any surface — for production runs or for short runs with frequent imprint changes. And the wide choice of Markem specialty inks offers various drying characteristics and resistance to almost any environmental condition. Machines, printing elements, inks, supplies, plus competent advice and service — all are available from Markem, the complete source, with 49 years of experience in industrial marking.







Helping your product speak for itself

MARKEM (U. K.) LIMITED
24 Brownfields
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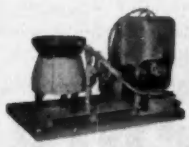
MACHINEHANDEL H. RUSCHE
Via Maartensdijk
Hollandsche Rading, Holland

HERE'S HOW TYPICAL MARKING NEEDS ARE MET BY MARKEM

Model 146A — Marking Axial Lead Components with complete legends, including polarity band. Prints neatly on curved, uneven or irregular surfaces. Can be adjusted quickly to different sizes of components. Production speed up to 3000 per hour.

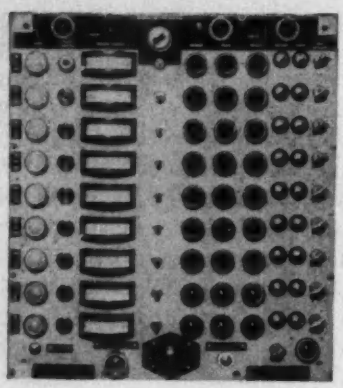


Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 3000 per hour.

Model 148A — Completely Automatic Marking of all types of surfaces — flat, curved, corrugated, irregular, etc. — without hand rolling or pressing. May be mounted for automatic in-line marking or objects may be hand fed to adjustable work table. Average production 2100 to 3100 per hour.

Model 69A — Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components up to 4800 per hour. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.

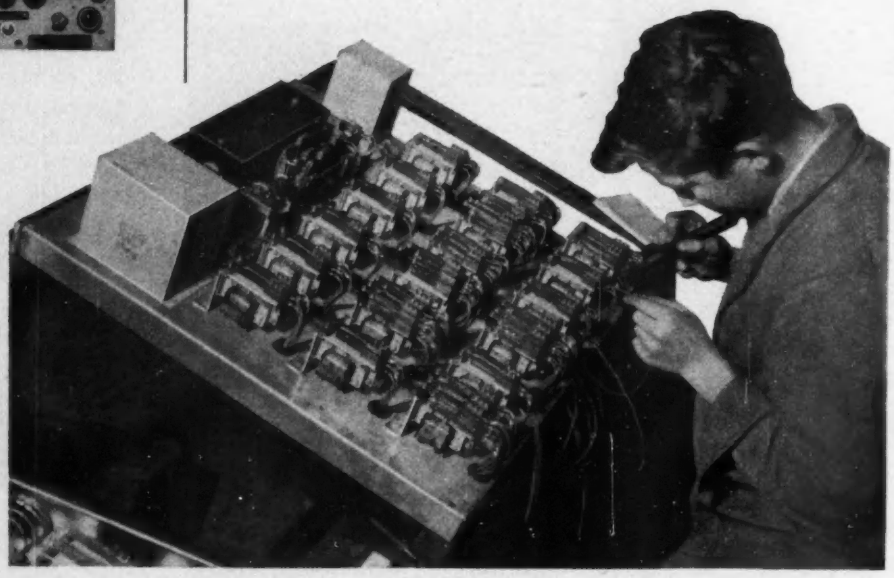
Write for this 12-page catalog of Markem machines and related equipment for the electrical and electronics industries. Complete specification sheets are also available for individual machines.

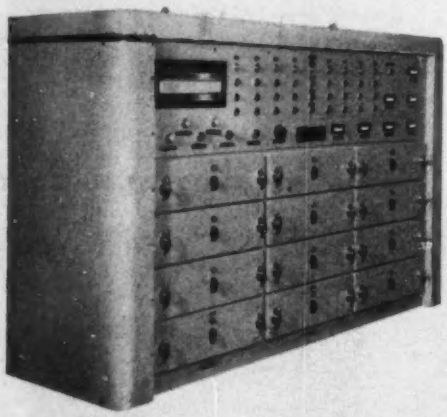


under one roof...

construction and assembly of modern control gear

Built to the design and specification of PEABODY LTD





The specialised engineering skills of Lintotts range from the precision machining of heavy metal castings or forgings down to light sheet pressings or stampings. For control panels, cabinets and desks, as currently being applied to the electronics and nuclear energy fields, Lintotts also undertake the complete electrical assembly. An example of this integrated service is shown here for burner control: *top* a remote sub-control panel, *centre* assembly of a control rack, *left* a composite control cubicle.

These same skills can be harnessed to many other construction forms. Your enquiries are invited with a view to collaboration on any project at the drawing board — yours or ours.

LINTOTT ENGINEERING LTD.

AYLING INDUSTRIES GROUP

Horsham, Sussex. Telephone: Horsham 3316

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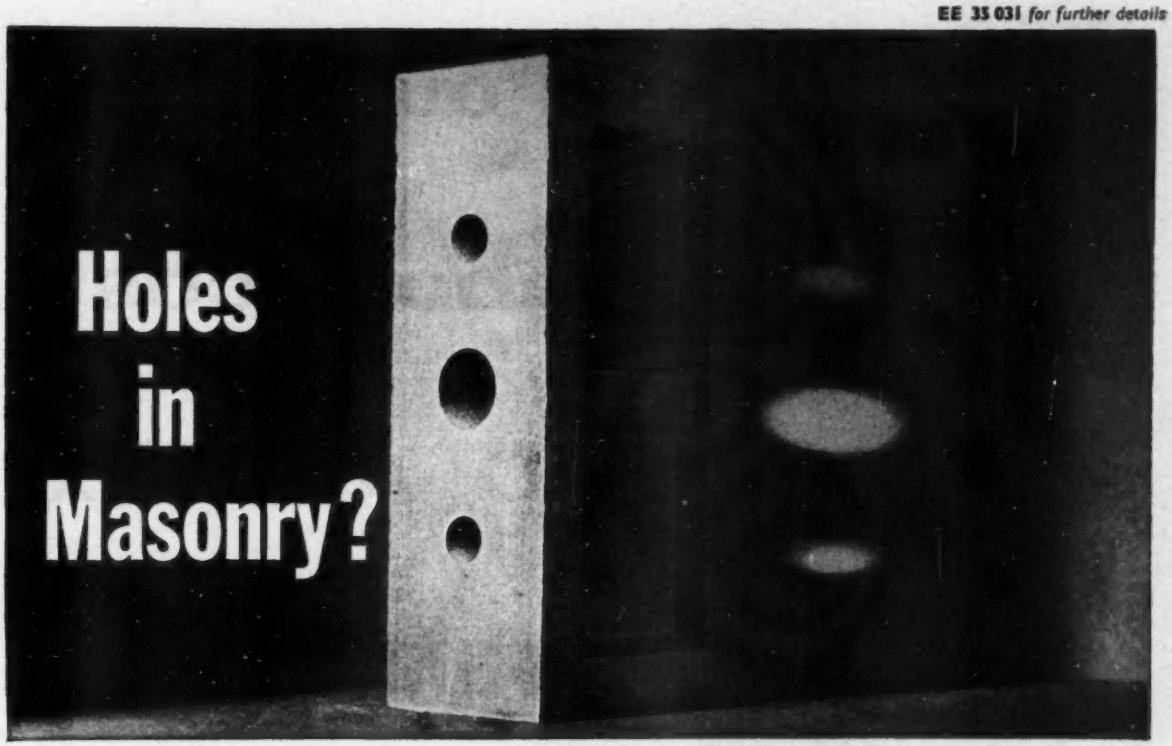


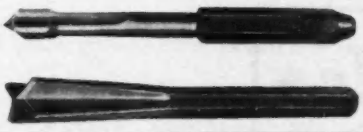
It's far quicker with RAWLPLUG TOOLS

The outstanding quality and endurance of Rawlplug Hole Boring Tools save their cost over and over again in speedier, more accurate work and longer life. Whatever the job—few holes or many—these are the Tools that are most economical in the long run. And with Rawlplug Tools that's a very long run indeed!

TOUGH, FAST-CUTTING TOOLS FOR DRILLING Brick, Slate, Concrete, Marble, Tiles, etc.

HAND TOOLS

For only a few holes, hand percussion tools may best suit your needs. They are of many sizes and types—Rawldrills and Stardrills (for brick, concrete, etc.). Wall Boring Tools and Tubular Boring Tools (for boring right through walls and ceilings).



DURIUM DRILLS

These Durium drills with their almost diamond-hard tip, give astonishing cutting performances in brick, tile, cement etc. They are silent in action, and have a patented rapid-helix flute which forces out spoil and prevents clogging. First re sharpening FREE!

VIBROTO DRILLS

With their special cutting angle metallic carbide tips. Vibroto Drills give spectacular performances in drilling concrete, etc., and other hard materials. They are used in the Vibroto Drilling Machine, which has two *vibratory* actions (Light Rapid and Heavy Slow), and also a rotary action for use with standard Durium-tipped Drills.

THERE ARE 14 DIFFERENT TYPES OF

RAWLPLUG

HOLE-BORING TOOLS *For Speed and Endurance*

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Halve your labour costs

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ILFORD Azoflex Ninety Ninety dyeline paper is the fastest, most intense-line photoprinting paper ever known in Britain. Phenomenally fast—phenomenally clear and intense—new ILFORD Azoflex Ninety Ninety dyeline printing paper is available on 90 gm. base in popular cut-sheet sizes and rolls including 450-yard rolls for the Azoflex 150 Automatic machine, at the same price as FB 90 paper. Output can easily be doubled using the new paper, not only in power printers but also in machines with low-light sources. ILFORD Ninety Ninety can be processed in a universal developer and it can be used for projection printing.

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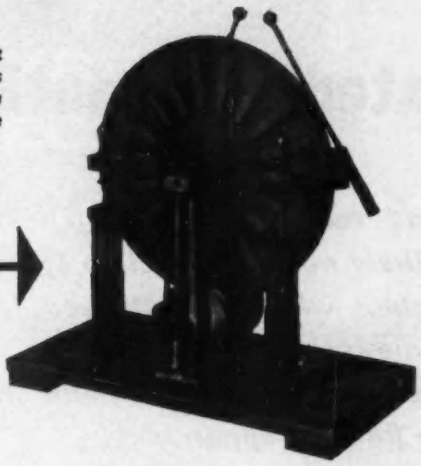
1885 WIMSHURST Influence Machine

During the years 1878-1888 Mr. James Wimshurst contributed considerably to the science of physics by designing and constructing a number of High Voltage Generators of the type shown in the illustration.



1961 HURSANT ELECTRONICS

are proud to announce their new range of regulated high voltage supplies which are of equal interest to the physicist and research engineer of today.

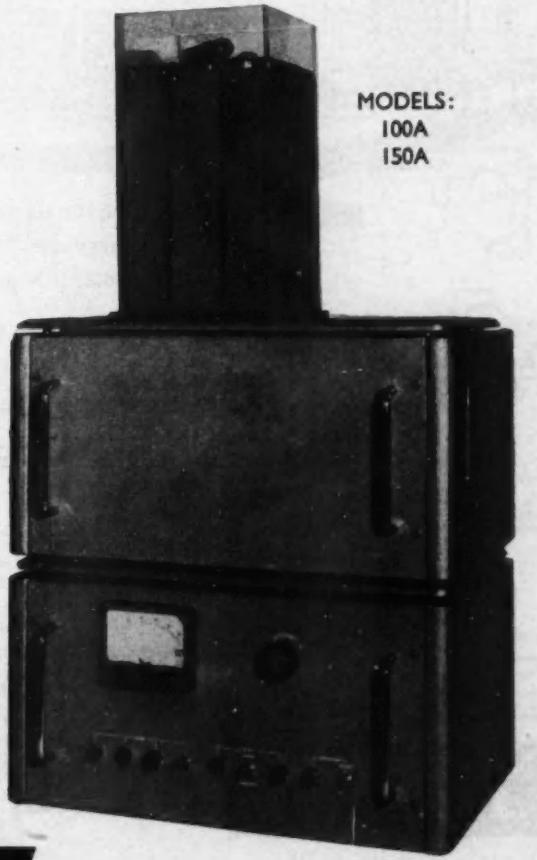
Model 30B	0-30KV	—2MA'S	£185
Model 50A	0-50KV	—1MA	£240
Model 100A	0-100KV	—700μA'S	£340
Model 150A	0-150KV	—500μA'S	£450

All models listed have continuously variable and reversible polarity output, and are fitted with kilovoltmeters, current meters, and overload trips as standard.

Small Physical Size.

Robust construction, low ripple and good regulation are also features of these supplies which are offered at the prices shown above.

MODELS:
100A
150A



A leaflet giving further details is available on request

See our exhibit at the Northern Electronics Exhibition, Manchester, July 6th-12th 1961.

HURSANT ELECTRONICS LTD

13-14 The Mall Ealing W.5.

Telephone: EALing 7176

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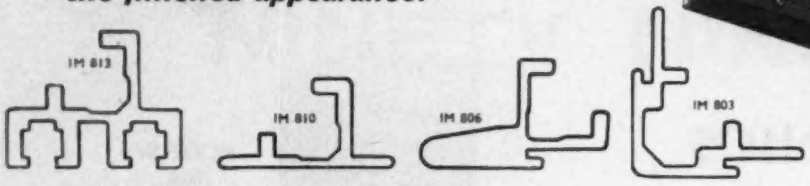
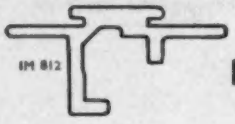
new MINIATURE IMLOK

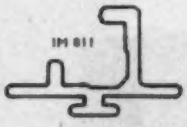
extends versatile IMLOK range

Send today for full details of this entirely new construction system—the system which permits you to make frameworks in any size from 4¼" cube upwards and with a unique choice in the finished appearance.



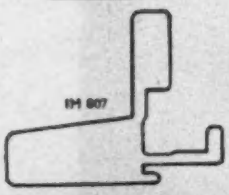


MINIATURE IMLOK can be used for a multitude of purposes including chassis framework, component and instrument housing, display fittings and shelving, showcases, etc.

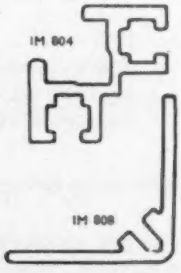


MINIATURE IMLOK uses the established principles of the IMLOK Construction System, with die-cast aluminium connectors and a wide variety of interlocking aluminium extrusions.

MINIATURE IMLOK because of its range of extrusions, allows the widest possible choice of constructional methods and finishes, with extrusions for recessed panels, extrusions for glass and door frame extrusions.



MINIATURE IMLOK is designed for labour-saving simplicity. It is ideal for prototype or small production runs, and is equally suited to large quantity requirements.



MINIATURE IMLOK economical, versatile, quick and simple!

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Denmark: Tage Schouboe, Copenhagen N
France: E.G.E.E., Paris (19)
Holland: J. Th. van Reijsen, Delft
Italy: Stuart Culley, Milan
Mexico: Aluminio Arquitectonico, S.A., Mexico D.F.
Morocco: E.G.E.E., Paris (19).
New Zealand: Imarex (1960) Ltd. Auckland C3
Norway: Birger Christensen, Oslo
Portugal: Projectos e Construções Ltda, Lisbon
South Africa: Switchcraft (Pty) Limited, Johannesburg
Sweden: Electronlund AB, Malmo 1
Switzerland: Walter Blum, Zurich 2/39
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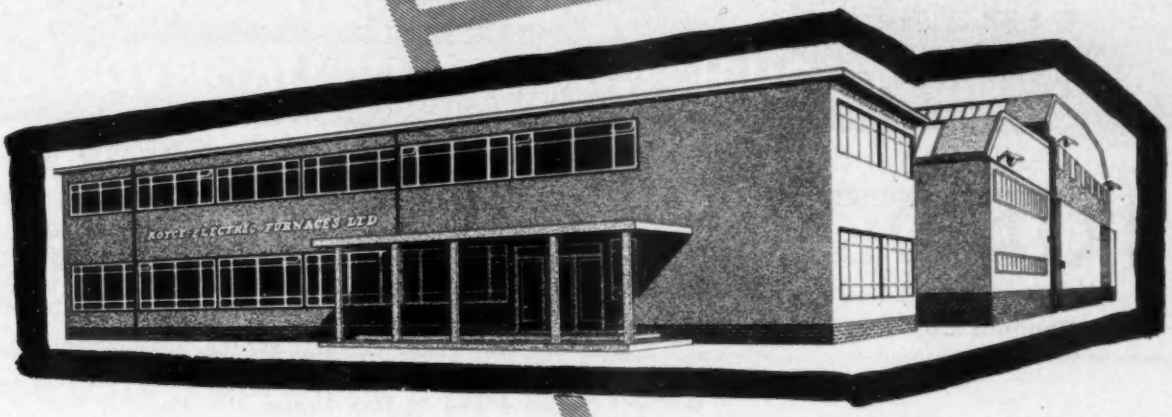
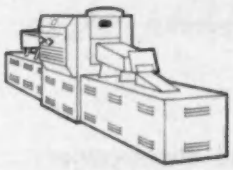
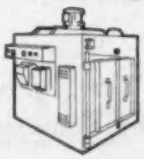
U.S.A.: Bud Radio Inc, Cleveland 3, Ohio
British Guiana: Davsons Caribbean Agencies Ltd, Georgetown

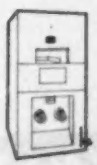
a new home for **ROYCE 'SPECIALS'**



ROYCE furnaces specially designed for your requirements cost no more than standard plant







This new, well equipped factory at Sheerwater, Surrey, is a fitting home for Royce Electric Furnaces—a stable worthy of the thoroughbreds it produces!

Now more than ever you should specify a Royce furnace. Choose from the comprehensive range of Royce Standards or have a Royce 'Special'—a furnace designed for *you* to meet *your* requirements.

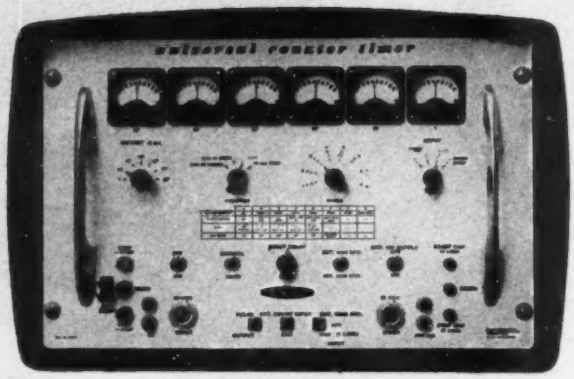
For your new furnace get a quotation from Royce.

ROYCE

ROYCE ELECTRIC FURNACES LIMITED

ALBERT DRIVE SHEERWATER WOKING SURREY *Telephone: Woking 5401-4*

Transistorized UNIVERSAL COUNTER TIMER



Frequency Measurement

Random Counting

Frequency Division

Time Measurement

Frequency Standard

This fully transistorized portable equipment provides for a wide range of time and frequency measurement as well as facilities for counting, frequency division and the provision of standard frequencies. The facilities available are briefly listed below:

TIME/UNIT EVENT (1 LINE): For the measurement of the time interval between two occurrences in a continuously varying electrical function in the range 3μsec to 1sec. The time for 1, 10 or 100 such events can be measured.

TIME/UNIT EVENT (2 LINE): For time measurement in range 1μsec to 2777hrs. of any interval defined by a positive or negative going pulse in any combination.

EVENTS/UNIT TIME: For frequency measurement in range 30c/s to 1Mc/s over period of 0·001, 0·01, 0·1, 1 or 10secs. Crystal accuracy ±2 parts in 10^6/week. For mains or 12Vd.c. operation.

Full technical specification available on request.

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WORSLEY BRIDGE ROAD · LONDON · SE26
HITHER GREEN 4600

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GERMANIUM P N P

ALLOY-DIFFUSED

MESA TRANSISTORS

TO COVER ALL V.H.F. & SWITCHING APPLICATIONS

FOR HIGH GAIN I.F. AMPLIFIERS AT 465 kc/s and 10 Mc/s

20V Collector Rating
100 mW Dissipation
80 Mc/s f_T

2G401

FOR V.H.F. AMPLIFIERS & OSCILLATORS HIGH GAIN I.F. AMPLIFIERS AT 38 Mc/s

20V Collector Rating
100 mW Dissipation
10 dB minimum gain @ 100 Mc/s

2G402

FOR FAST CURRENT-MODE SWITCHING AND PULSE APPLICATIONS REQUIRING FAST RISE TIMES

40V Collector Rating
100 mW Dissipation
130 Mc/s f_T

2G403

HERMETICALLY SEALED TO-5 case FOR COMPLETE RELIABILITY UNDER ALL CONDITIONS

COMMUNICATIONS · COMPUTERS · PROCESS CONTROL
MEASUREMENT · INSTRUMENTATION

Send today for full details of these significant new transistors

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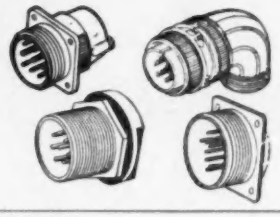
ELECTRICAL CONNECTORS (PLUGS AND SOCKETS) for EVERY conceivable application

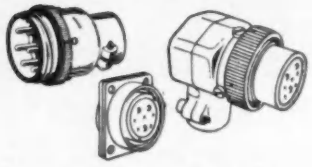
AIRCRAFT ENGINE, INSTRUMENTATION, INDUSTRIAL AND GENERAL ELECTRONICS APPLICATIONS—THE MS SERIES CONFORMING TO MIL-C-5015D

The MS and MS related series can provide connectors with the following characteristics:— High-temperature, vibration-proof, lightweight, environmental, radiation-resistant, potting, bulkhead, hermetically sealed, splashproof, waterproof. They are available with from 1 to 100 contacts, 15 different insert diameters from ½" to 2½", over 260 contact layouts, 6 shell styles, current rating from 10 to 200 amps, working voltages from 200 to 50,000 volts AC. Contacts are precision machined from high quality copper, silver plated to ensure low contact resistance. All other components are manufactured to extremely high precision standards and provide the utmost in reliability.



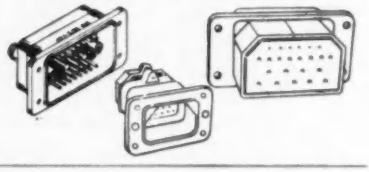
GENERAL CIRCUITRY AND INDUSTRIAL APPLICATIONS—THE K AND RK SERIES

A general purpose, rugged durable range, offering:— Acme coarse thread coupling; conduit or cable clamp entry, lightweight construction. Available with from 1 to 110 contacts, including coaxials, in eight different insert diameters from ½" to 2½". There are 7 basic shell styles accommodating more than 220 insert arrangements with current ratings of from 10 to 200 amps and a variety of voltage capacities. Contacts are brass, silver plated; Insulators of high quality phenolic, melamine or formica. Shells are cadmium plated aluminium alloy. Hermetically sealed types available with steel shells. An audio/video series is available in this range.



UNIT-PLUG-IN RACK/PANEL APPLICATIONS:—THE D AND DP SERIES

This rectangular range of connectors permit rapid disconnection, interchange, replacement, testing and inspection of assemblies and sub-assemblies. Designed for "rack and panel" applications, both mating halves can be rigidly mounted, or one can be cord connected if required. There is a vast range available including hermetically sealed, pressurised and environmental types. 2 to 224 contacts can be provided in rectangular inserts ranging in size from ⅝" x ⅝" up to 2½" x 4½", with a great variety of current and voltage ratings.

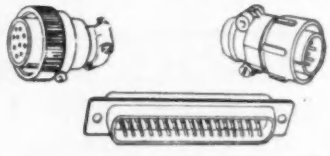


AUDIO/VIDEO AND LOW LEVEL CIRCUIT APPLICATIONS

Six different ranges are available which can primarily be identified by their latch-lock coupling mechanism, a device which permits rapid positive engagement whilst preventing accidental disconnection of trailing cables. Rugged cylindrical shells permit use under arduous service conditions. 1 to 18 contacts, with current ratings from 10 to 30 amps are provided in insert diameters 1" or smaller.

MINIATURE AND SUBMINIATURE SERIES

These ranges of connectors are already extensive but are continually expanding due to current weight-space limitations of modern flight. Designed for amplifiers, miniature indicators, computor circuits, telemetering equipment and general instrumentation. The majority of contacts are 5 amp, gold plated copper. From 3 to 54 contacts are obtainable with miniature coaxials in some series. Rectangular or circular types. *Maximum* insert sizes are ⅝" x 1 7/16" for rectangular series and 1" diameter for circular. Hermetically sealed and environmental types available.

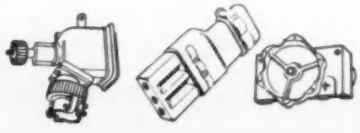


RADIO FREQUENCY COAXIAL SERIES

Available in a wide range of Series and types including subminiatures, MB-SM, HN, N, BNC. The latest development is the new aluminium series of R.F. connectors and adapters designed for use with semi-flexible aluminium sheathed cables, where weight saving is a critical design criteria. Currently available are types TNC, N, C, SC, LT and LC plugs and jacks.

OTHER SERIES AND APPLICATIONS

Cannon Electric (Great Britain) Ltd. also has available connectors for the following applications:— Guided Missile Launching, Battery and Power Supply, Laboratory and Switchboard, Printed Circuit, Manometer air line, Buffet and Aircraft Galley. In addition there are comprehensive ranges of AC and DC Solenoids, and "Kwik-Term" Subminiature, feed-through and stand-off terminals. A brand new development is the "Morpho"—a multi-pin, modular connector of hermaphrodite construction. Has crimp contacts. Is ideally suitable for commercial applications where space, ease of wiring and neat external appearance are critical factors.



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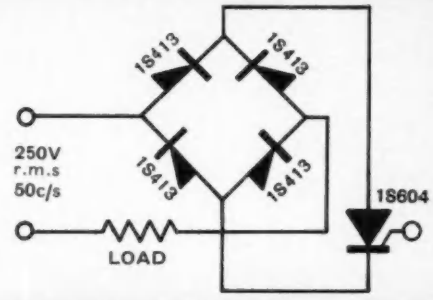

ACTUAL SIZE

The circuit shown requires only one silicon controlled rectifier, thus reducing costs in many applications. A.C. mains voltage is applied to a bridge rectifier in series with the load. The current is controlled by operating the silicon controlled rectifier, which is placed across the bridge, as a switch. The S.C.R. is fired by a pulse generator which can be based upon a complementary bistable circuit using Texas 2S301 and 2S701 silicon industrial transistors.

Type	Description	Peak Inverse Voltage and Forward Breakover @ 125°C* P.I.V (V)	Max. Mean D.C. Forward Current @ 65°C* I_o (A)	Max. Mean D.C. Forward Current @ 125°C* I_o (A)	Max. Gate Current required to turn device on I_{GF} (mA)	Max. Sustaining Current I_H (mA)
1S600	Stud mounted	50				
1S601	device with an	100				
1S602	extremely small	200	3	1	20	25
1S603	gating power	300				
1S604	requirement	400				
1S610	Mounted in a	50				
1S611	standard TO-5	100				
1S612	transistor case	200	1	0·3	20	25
1S613	and having a	300				
1S614	1A rating	400				

*Stud or case temperature.

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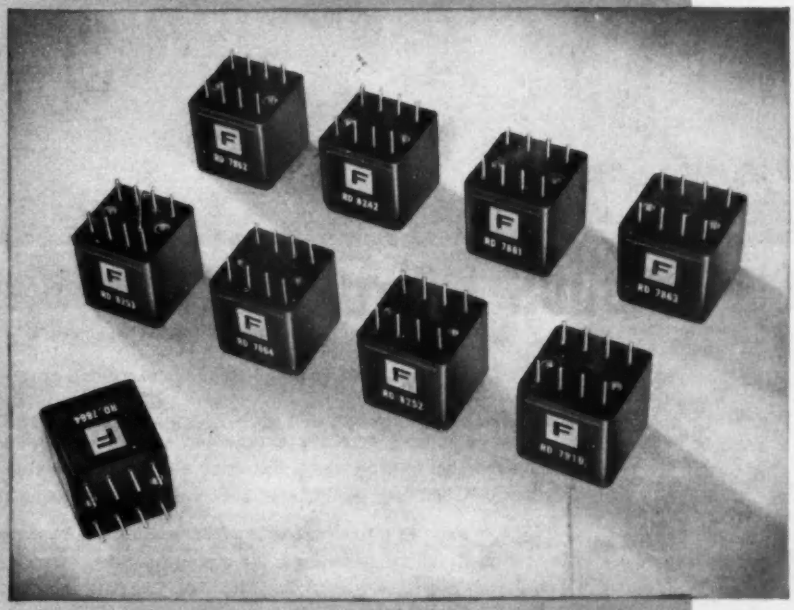

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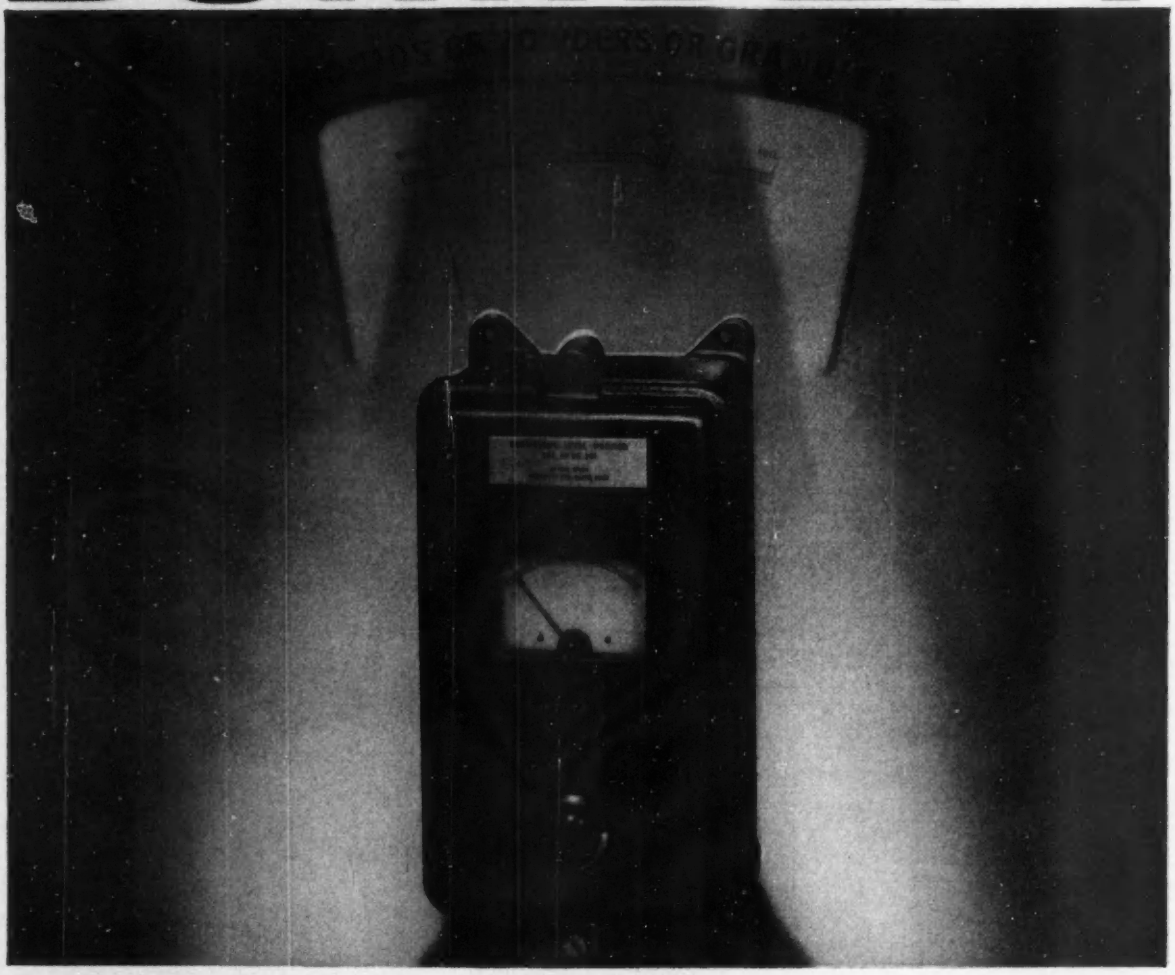

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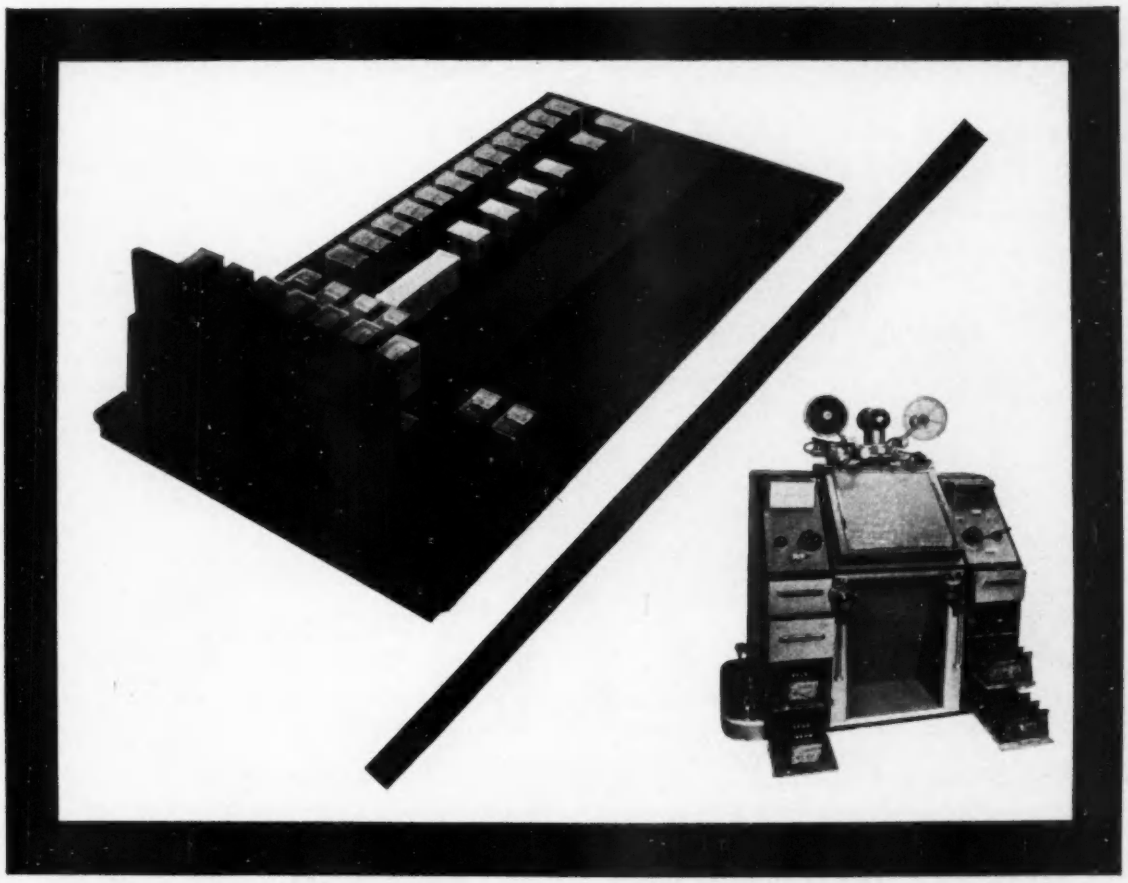

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84-86 REGENT STREET, LONDON, W.I.

TELEPHONE: REGENT 8020

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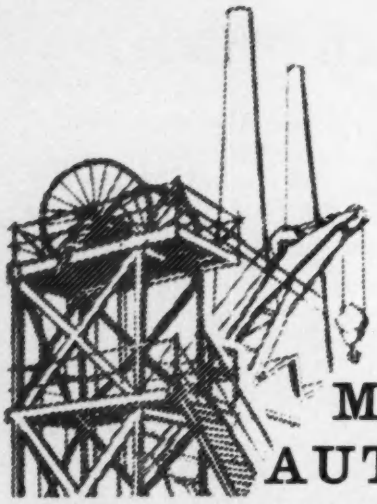

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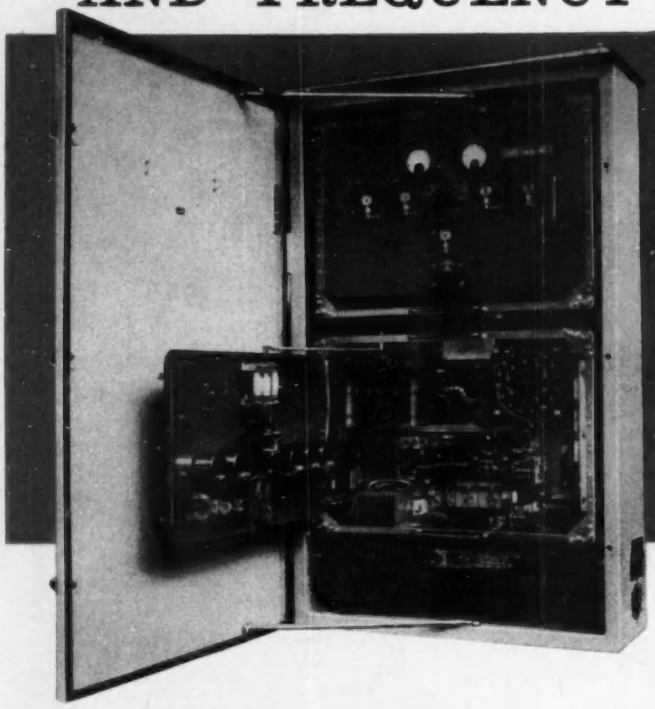

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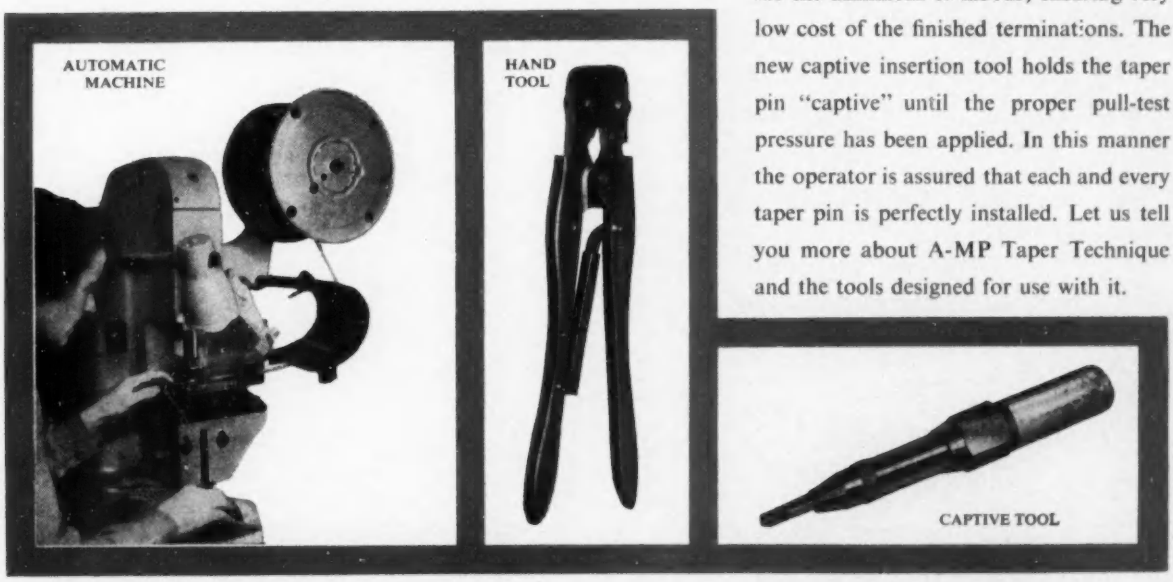

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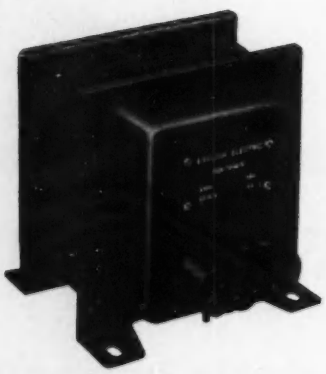

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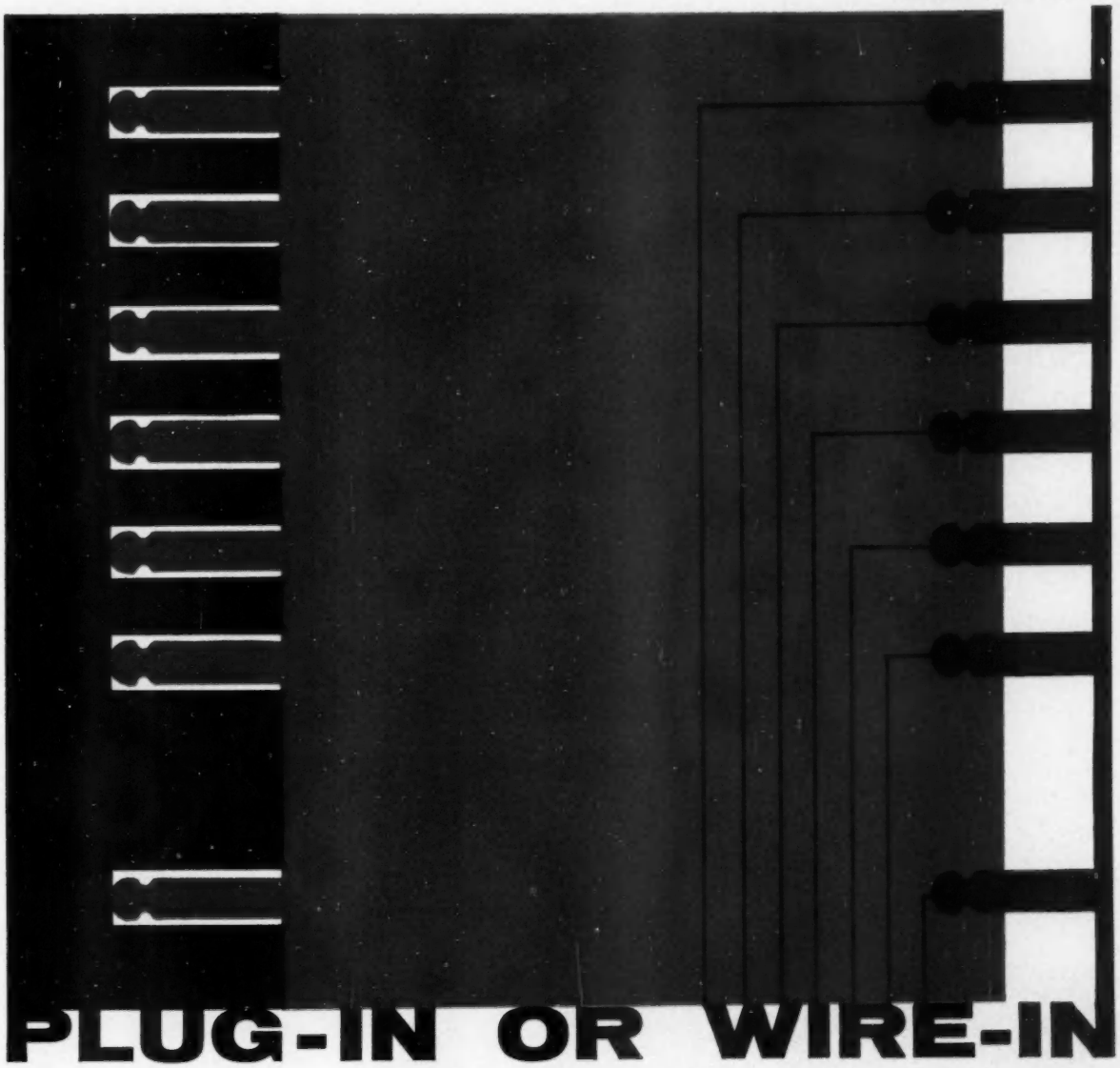
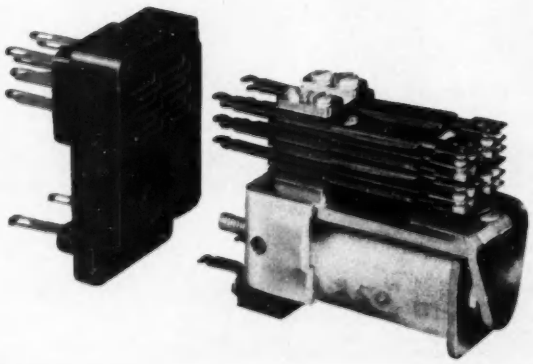


PLUG-IN OR WIRE-IN



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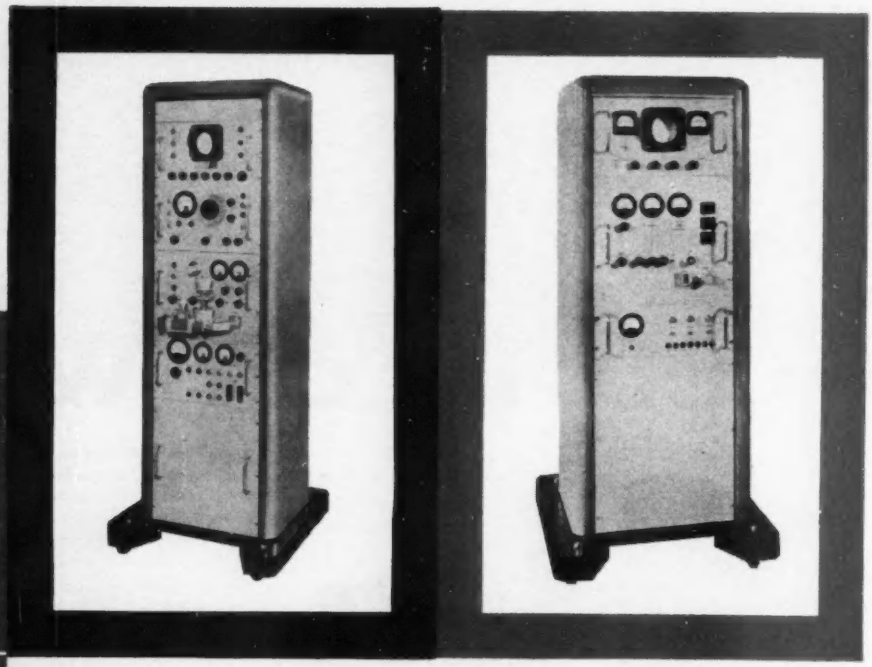

LEFT
Noise Measuring Equipment Type 123 employs a sensitive microwave frequency discriminator and may be used to isolate and measure spurious A.M. and F.M. modulations at frequencies up to 90 Kc/s removed from the carrier with a resolution of 70 c/s or 1 Kc/s.

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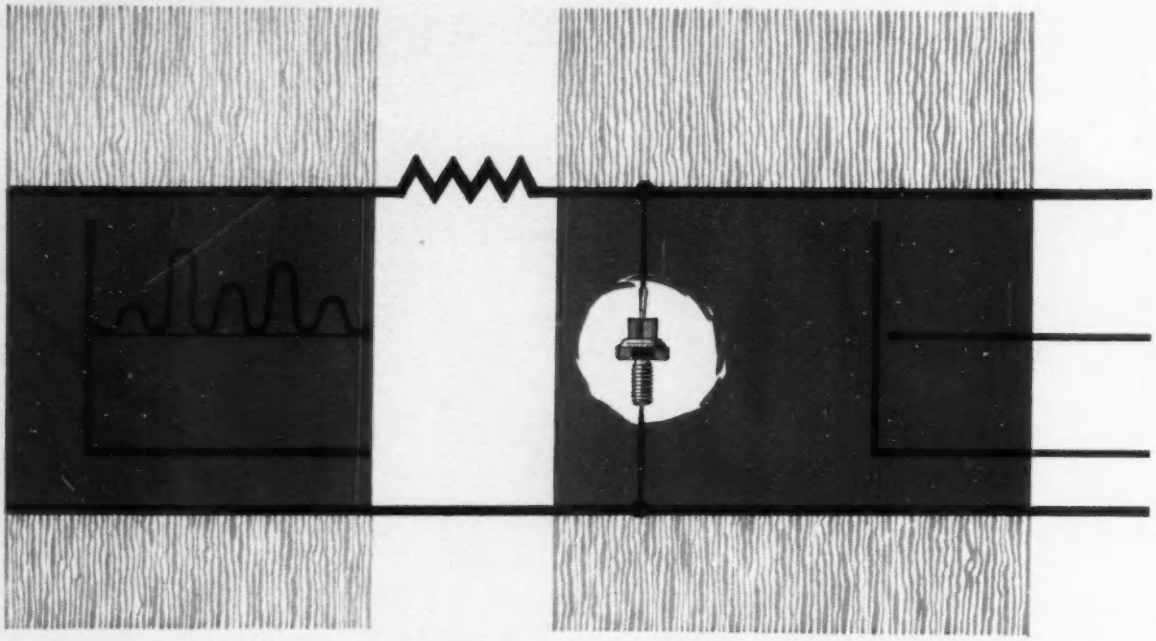

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ZD 512 CD 512	12	10
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ZD 522 CD 522	22	10
ZD 527 CD 527	27	10
ZD 533 CD 533	33	10

★ ZD indicates Zener
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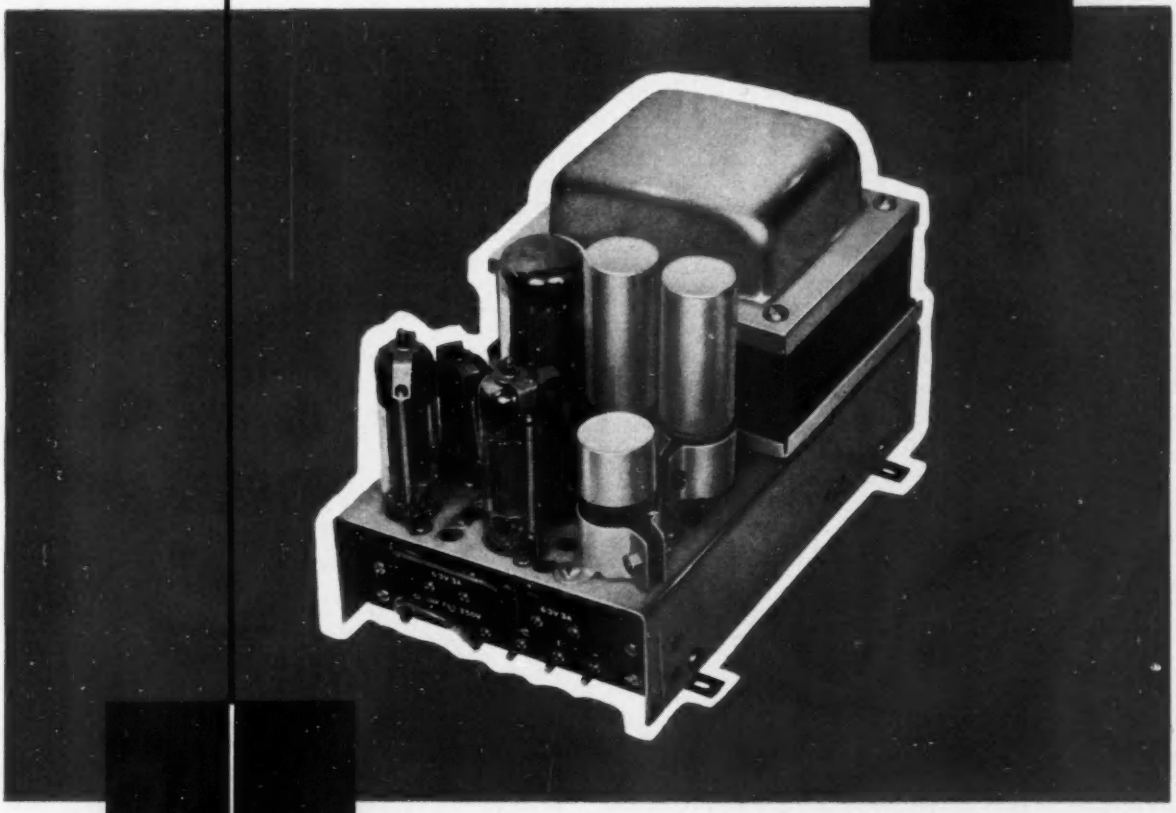

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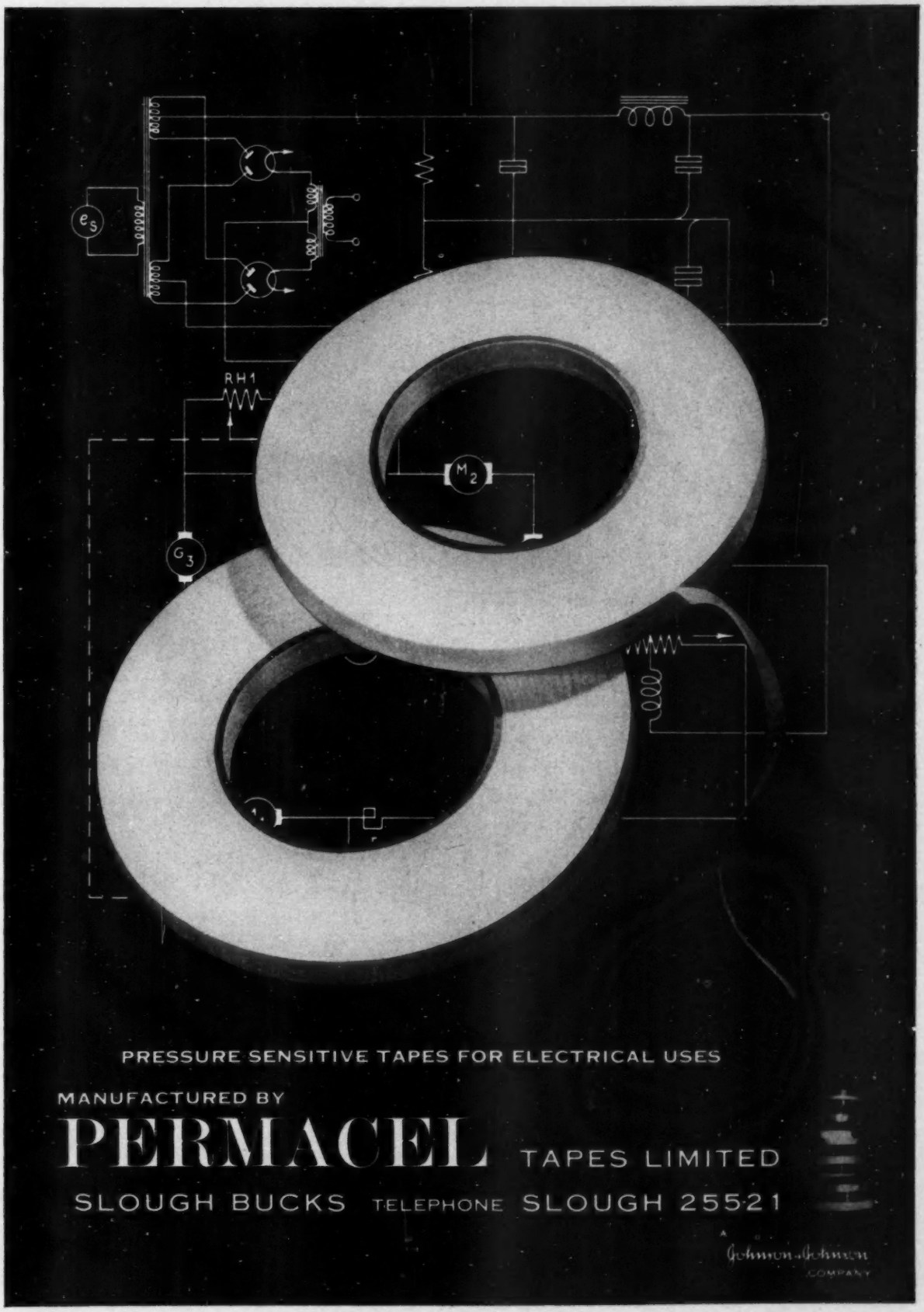
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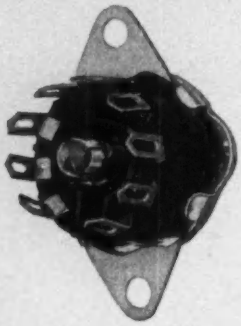

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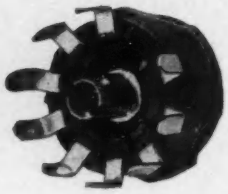

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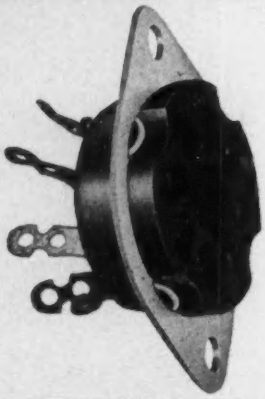

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VALVEHOLDERS FOR PRINTED CIRCUITS AND CHASSIS MOUNTING

Now you can cut the cost of your product without taking chances with quality. Clix prices are down, and we've done it by efficient production planning and modern equipment—not by skimping materials, finish or workmanship.

These B9A valveholders show you what we mean—all tags are readily bendable. Bell-mouth contacts give reliable, low contact resistance. The saddled version will take either spring retainers or Clix screening cans yet they are smaller than the normal skirted types. We can also supply them with a reverse saddle for under chassis mounting and a loose skirt for bayonet type screening cans.

The International Octal Valveholder illustrated can be mounted above or below the standard 1¼" chassis hole. 6-point contacts give low electrical resistance with smooth-insertion too, and *really* bendable tags. We'll be happy to send you samples and talk prices.

AEI **CLIX ELECTRONIC COMPONENTS**

Associated Electrical Industries Limited · Radio & Electronic Components Division · 155 Charing Cross Road · London WC2 · Tel: GERrard 9797

TA17/44

EE 35 055 *for further details*

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A new compact instrument suitable for the measurement of D.C. voltages and currents, A.C. voltages and ohms. Its high sensitivity renders it suitable for testing and fault location in all types of electrical and electronic circuits. It is well built to ensure long and satisfactory service. The instrument is economically priced and supplied with test leads with plug connections at one end. (Leather carrying case available as an extra).

Send for leaflet No. MIN 6009/EE

RANGES	
A.C. volts.	2.5, 10, 25, 100, 250, 1000.
D.C. volts.	2.5, 10, 25, 100, 250, 1000.
D.C. amps.	50 μA, 1mA, 10mA, 100mA, 1A.
Ohms.	2000 200,000 . 20 MΩ

ACCURACY	
D.C. Volts & Amps.	± 2% of full scale deflection
A.C. Volts.	± 3% of full scale deflection + 5% at centre scale.

SEI

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PEEL WORKS · SILK STREET · SALFORD 3 · LANCASHIRE Tel: Blackfriars 6688

London Sales Office: MAGNET HOUSE KINGSWAY W.C.2 Telephone: Temple Bar 4668

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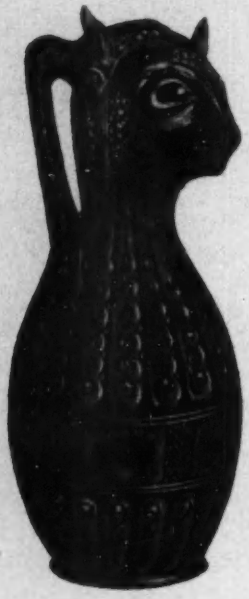
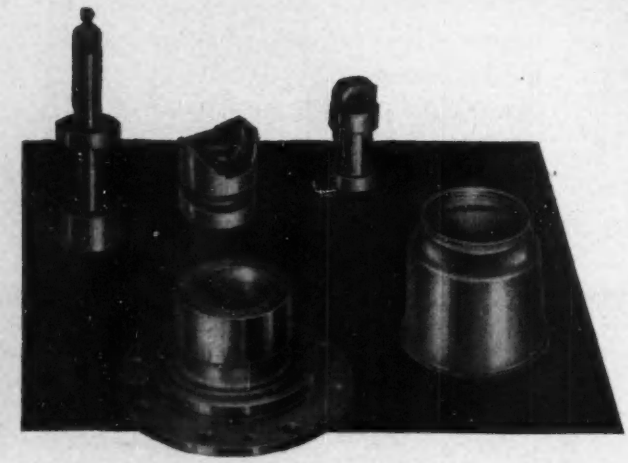


The fine artistry and painstaking craftsmanship which went into the making of this treasured pitcher would be outstanding in any age. That it was fashioned in the sixth century B.C. is an incredible feat of human skill.

PUTTING A FACE ON IT...



The ancients found their own techniques by a process of trial and error and a desire for greater ability.

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In contrast, we at Ionic have found our techniques by increasing research and constant experiment. Thus we are keeping ahead of the demands of modern industry.

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PRECISE RESETABILITY
LAW ACCURACY ± 1.0% (ABSOLUTE)
or 0.25% IF REQUIRED

This ¾" diameter Helical of high quality yet inexpensive has been designed for manual operation and is available in two versions

1. **For standard wiring**
2. **For PRINTED CIRCUIT application using the accepted 0.1" grid.**

HELICALS BY RELIANCE

10-TURN MINIATURE

TYPE HEL 07-10

SPECIFICATION

Resistance Range	**100-30,000 ohms**
Resistance Tolerance	**±5%**
Law Accuracy (Absolute)	**±1.0% or better to within 0.25% if required**

Independent Law Accuracy to closer limits

Rotation—effective angle 3600° +10° −0°

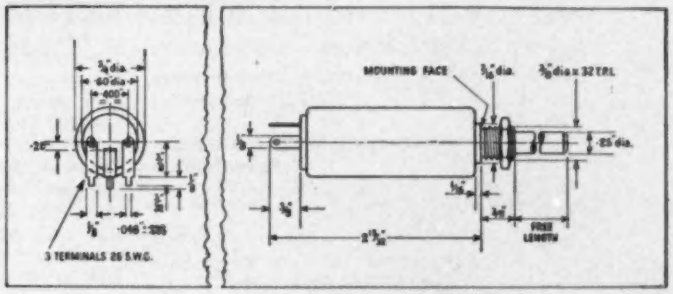
Dials available if required

Send for Data Sheets 11 and 12 which give full technical details and dimensions

For SERVO application an entirely new Low Inertia multi-turn Syncro size unit is available

See below ★

DIMENSION DRAWINGS OF PRINTED CIRCUIT & STANDARD VERSIONS HEL 07-PC10 & HEL 07-10



★ FOR RESEARCH AND DEVELOPMENT ENGINEERS

concerned with servo systems, function generation and environmental simulation, Reliance by means of an entirely new technique (covered by world wide patents) have developed and offer a multi-turn Potentiometer embodying in a single unit the following outstanding advantages:

Size 11 Syncro Mounting
Low Torque <6 gm. cm
Low Inertia <0.01 gm. cm²
High Resolution
Multi Tapping Facilities
Multi Ganging

RELIANCE *RELIANCE MANUFACTURING COMPANY (Southwark) LIMITED*

Sutherland Road, Higham Hill, Walthamstow, London, E.17. *Tel: Larkswood 1118/9*

GD 767

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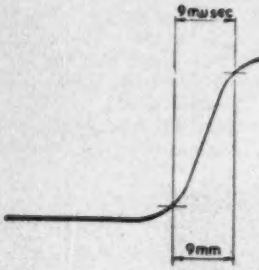
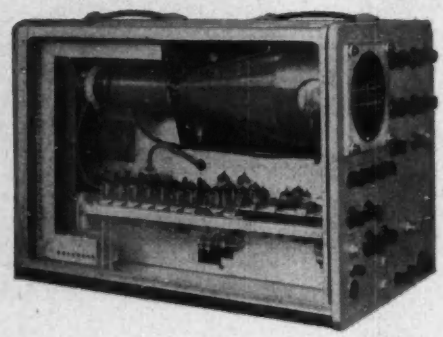


The Sign of a good High Speed C.R.O



The above depicts the optimum performance possible with

THE NAGARD MODEL 301

Designed around the latest type of high sensitivity cathode ray tube. this instrument provides all the essential features of a wide band oscilloscope with accurate measuring facilities and an exceptionally wide range of sweep speeds. The aim has been to get these features incorporated in the least complicated manner, and produced to the highest standard of workmanship at an economical price.

The design is clean, simple, reliable and easily serviced. Valves are given favourable conditions so that normal ageing does not render the instrument inaccurate.

Calibrated Sweep Rates: 0.1 μsec/cm to 5 sec/cm in 21 steps within 2% accuracy over most of the very wide range. Continuously variable fine control and calibrated sweep expansion × 10 gives maximum velocity of 1 cm/0.01 μsec.
Trigger Setting in six modes with level, stability and polarity controls.
Vertical deflection over a bandwidth of DC to 40 Mc/s (−3bB).

Rise time: 9 mμsec.

Sensitivity: 1 cm/100 mV to 1 cm/20 V continuously variable, extended to 1 cm/200 v by probe. Calibrated and stable gain settings.

D.C. Level Check: Locates zero D.C. level of signal.

Pre-amplifier: Can be switched in and then provides:—
Maximum Sensitivity of 10 mV/cm over bandwidth of 2.5 c/s to 20 Mc/s.

C.R.T. Has 10 KV accelerating voltage and high efficiency screen giving exceptionally good resolution and high writing speed.
Illuminated graticule with easily read rulings for rise time and other measurements.

Now in Production: After proving a series of prototypes over the past 3 years, and incorporating 10 years of specialised experience this instrument is one of a new range of first class oscilloscopes for the discriminating user. Ask for Data Sheet No. 1260.

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This is news!

now...a *transistorized* chopper

Price in the U.K. for small quantities, available from stock, £8.5.0d.
Unsealed versions of the SM.10 transistorized chopper are in use in the control systems of British Nuclear Power Stations and have already given three years trouble-free service — Thus proving their stability and reliability.

New from TMC comes the ELECTRONIC MODULATOR SM. 10 — the first fully encapsulated transistorized chopper to be produced and sold in quantity in Gt. Britain. The SM. 10 is a highly stable, clamp-type chopper with silicon transistors, designed for low level d.c. chopping. Unlike electro-mechanical choppers, the S.M. 10 has no moving parts to wear, or contacts to become contaminated. What is more, it will never need adjustment!

The SM. 10 has all these advantages:

- Noise level so low that it will switch a voltage of one microvolt.
- Extremely high stability over the temperature range 0° to + 55°C.
- Carefully matched, selected components give low drift and almost limitless life.
- Will operate from any 6 volt sinusoidal or square-wave supply—at frequencies from 40 c/s to 1000 c/s.
- Small and compact—fits B9A socket and measures only 1⅞" × 1¼" diameter.
- Epoxy resin cast and aluminium encapsulated — will withstand excessive vibration and shock effects (suitable for all military and commercial projects).

The SM. 10 is designed and manufactured by Bailey Meters and Controls Limited, and marketed by:—

TMC

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A MEMBER OF THE AEI *GROUP OF COMPANIES*

Accurate oscillograms from up to 12 separate sources immediately visible on one recording paper

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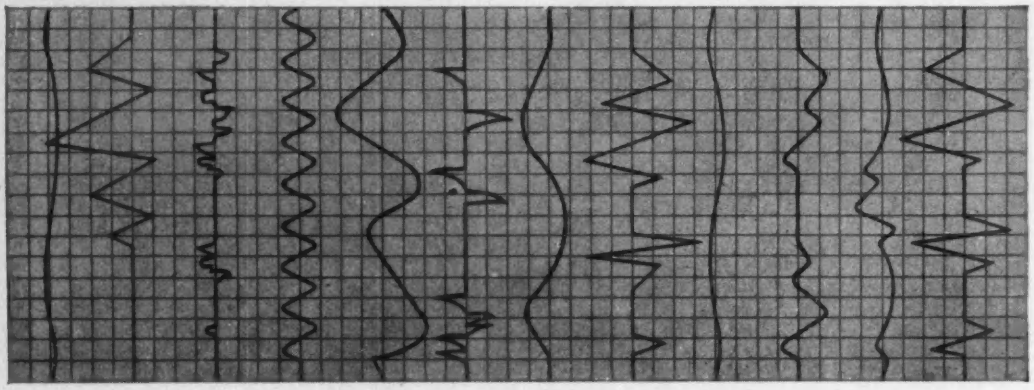

an advanced multichannel oscillograph

Where great accuracy in industrial or scientific measurement is vital, and particularly where one recording centre is necessary for a number of activities, the Oscillomink is indispensable. Up to 12 channels can be operated simultaneously without disturbance to individual readings, even where they cross or coincide. Other models offer 2, 4 or 8 channels.

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- Immediately visible records
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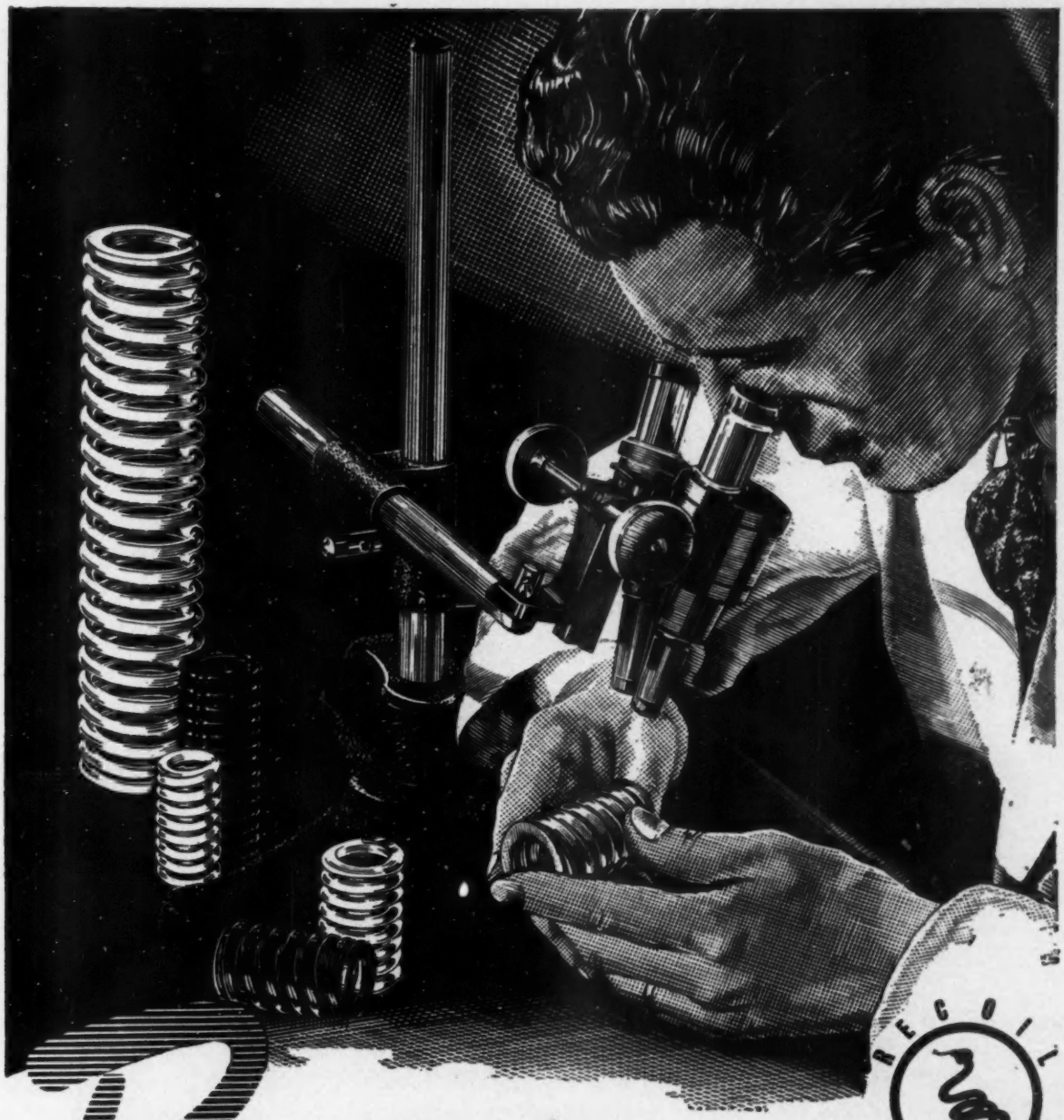

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SIMA

a unique source of INFORMATION on scientific instruments

There are two kinds of knowledge; knowing and 'knowing where to find out'. With science and technology developing so rapidly no one can hope to be fully informed on every worthwhile new technique or new equipment.

Here are three ways in which 'knowing where to find out' can help you:

(1) If you already know the answer to your problem but don't know who makes the most suitable equipment SIMA can tell you.

(2) If the answer to your problem depends on whether someone has already developed suitable equipment, SIMA will know if it exists and can tell you where to get it.

(3) If you just have a problem, SIMA can often tell you whether someone has already found the answer to it and has developed equipment to meet it.

Where do SIMA get their information?

From two sources. One is The British Scientific Instrument Research Association (BSIRA) which is constantly engaged in research and maintains extremely comprehensive libraries and files. The other is the membership, consisting of over 180 companies engaged in all these fields of instrumentation:

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ELECTRONIC & NUCLEONIC	MEDICAL & X-RAY
ENGINEERING & INDUSTRIAL	KINEMATOGRAPHIC
NAVIGATIONAL & SURVEY	PROCESS CONTROL & AUTOMATION

The Scientific Instrument Manufacturers' Association could be your most valuable source of such information and you will find them very helpful on *any* question about scientific instruments.

the SIMA enquiry service

Over 180 manufacturers with one address

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Telephones—Secretariat Langham 4251 Enquiry Service Imperial 6000

Space donated by member: DAWE INSTRUMENTS LIMITED, *Specialists in Electronic Instrumentation*

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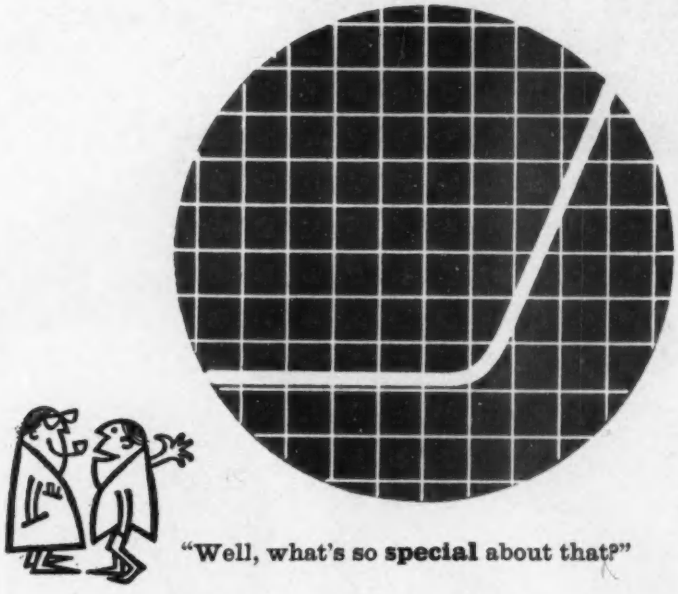

"Well, what's so **special** about that?"

DEFINITION

"O.K.—it's an ordinary characteristic but what isn't so ordinary is that we have got definition of this valve's performance. Definition in a special way that is. For instance, we know just what 'spread' we can expect in every batch that is delivered, and we have an indication of the spreads that we can expect over life.

This information is a tremendous help when you're designing equipment that's got to be reliable and you get it on Mullard Special Quality valves. You get this information because of the work they put in at their quality and test laboratories; with it you can design circuits that allow for possible valve variations and so achieve standards of equipment dependability that might otherwise not be possible.

Closely controlled characteristics are a feature of some Mullard Special Quality valves—others have a particularly long life expectation and some are designed for application where physical shock and vibration are likely to be experienced, some even have a combination of these features."

"When it comes to selecting the right valve for the right job, you know, the people at Mullard House are very helpful—they can give you all the facts you need and what's more they're always happy to discuss problems with you."

Mullard Limited Government and Industrial Valve Division,
Mullard House, Torrington Place, London, W.C.1. Telephone: LAN 5522

MVTA381

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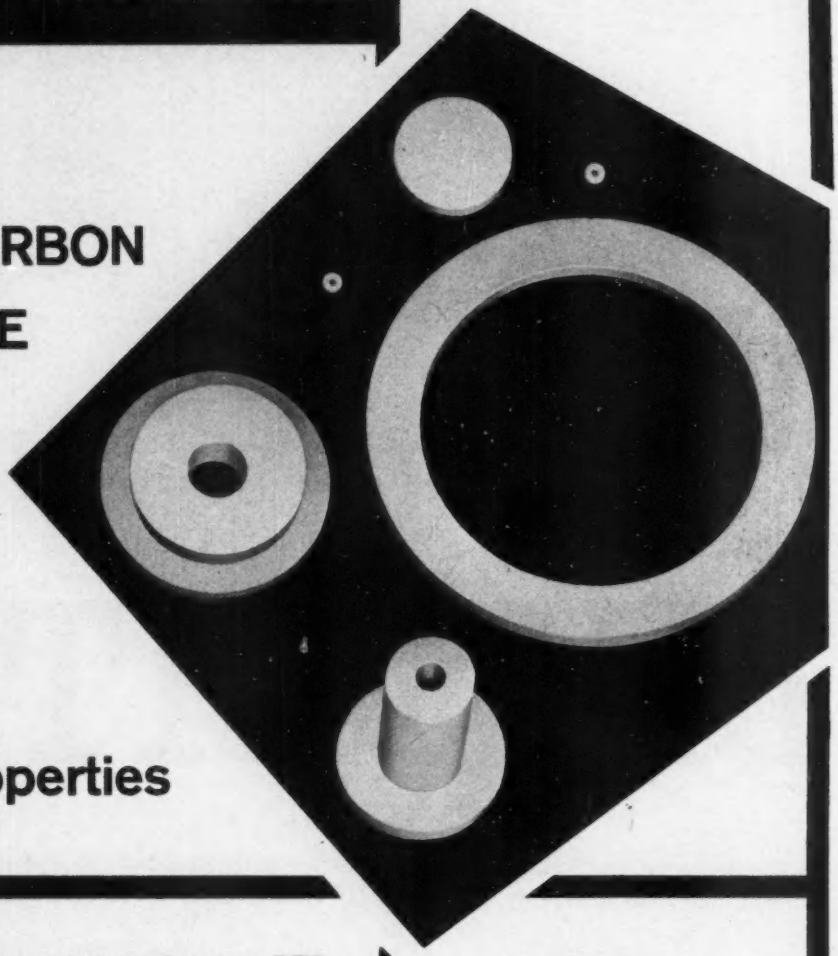
ROD TUBE TAPE CUSTOM MADE PARTS

A NEW FLUOROCARBON TFE BASE PRODUCT with improved mechanical and thermal properties



Extensive research has produced a new TFE base material with the following outstanding characteristics:

- ★ low thermal expansion only one sixth that of PTFE
- ★ exceptionally close moulding tolerances
- ★ chemical and electrical properties similar to PTFE
- ★ excellent friction and wear characteristics
- ★ greater stability against thermal shock

† **FLUOROSINT** *is a trademark of Polypenco Ltd., and is a material produced by a patented process.*

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Telephone: Welwyn Garden 5581-4

Associated Companies in U.S.A., France and Germany

PP/A 1/61.

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AEI INSTRUMENTATION INFORMATION SERVICE

LOW NOISE . . . LONG LIFE

AEI SYNCHRONOUS CHOPPER TYPE CK3

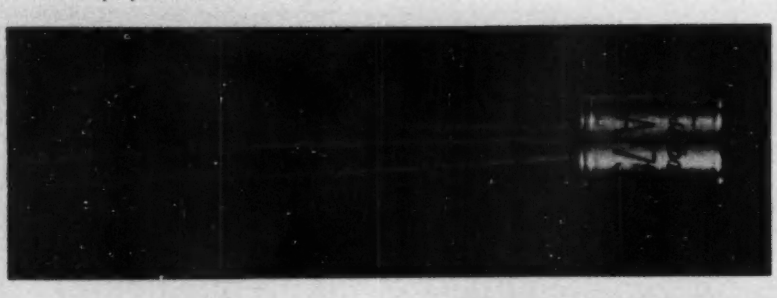
The AEI synchronous chopper is intended for chopping direct current from low power signal sources to alternating current of mains frequency, usually as a preliminary to a.c. amplification. It is suitable for both high-resistance and low-impedance transformer circuits. The type CK3 is widely used in such applications as the chopping of thermo-couple signals in temperature recorders and drift correction in analogue computer amplifiers.

The synchronous chopper type CK3 consists of a miniature contact assembly, actuated by a coil-driven reed vibrating at mains frequency (50 or 60 c/s). It fits a standard 9 pin thermionic valve holder type B9A and is available with either a 6.3 volt or 12.6 volt a.c. driving coil. A 100 c/s tuned version is also available.

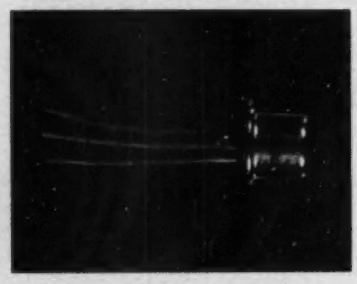
For further information write to:
AEI Instrumentation Division,
Instrument and Meter Department,
Trafford Park, Manchester, 17.

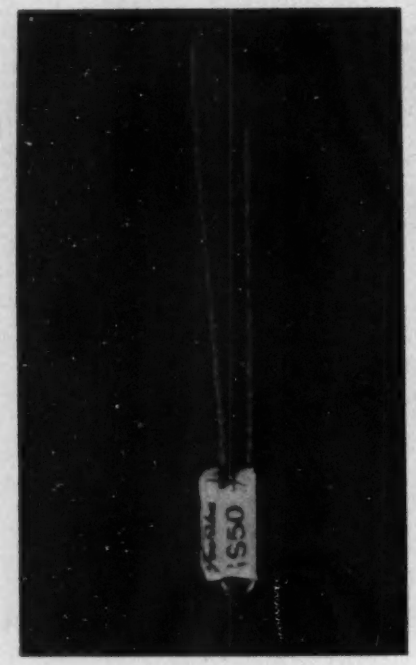
AEI | **Instrumentation Division**
Associated Electrical Industries Limited

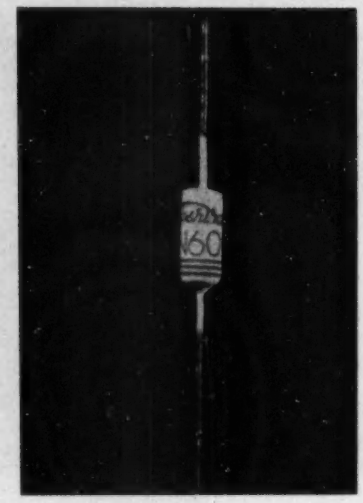
80/123

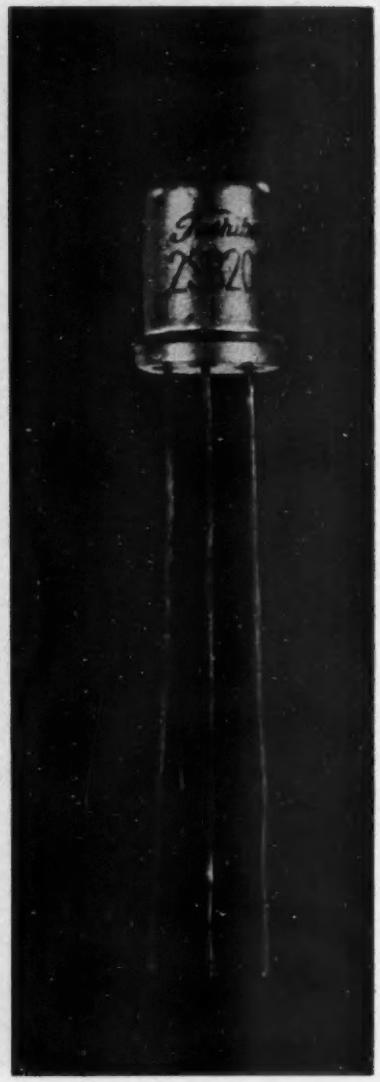


Toshiba









Semiconductors for Radio and TV

Germanium PNP Alloy Type Transistor

2SA49	For Intermediate Frequency Amplification (455Kc)
2SA52	For Converter Service (1.5Mc)
2SA53	For Intermediate Frequency Amplification (455Kc)
2SB26	For Audio Frequency Power Amplification
2SB54	For Audio Frequency Amplification
2SB56	For Audio Frequency Power Amplification
2SB189	For Audio Frequency Power Amplification
2SB200	For Audio Frequency Power Amplification
2SB202	For Audio Frequency Power Amplification

Germanium PNP Drift Type, Transistor

2SA57	For High Frequency Amplification (18Mc)
2SA58	For High Frequency Amplification (12Mc)
2SA60	For Converter Service (12Mc)
2SA72	For High Frequency Amplification (1.5Mc)
2SA73	For Converter Service (1.5Mc)
2SA92	For Local Oscillator Service (18Mc)
2SA93	For Mixer Service (12Mc)
2SA76	For High Frequency Amplification (VHF•FM)
2SA77	For High Frequency Amplification (VHF•FM)
2SA175	For High Frequency Amplification (22.5Mc)
2SA236	For Intermediate Frequency Amplification (455Kc)
2SA237	For Intermediate Frequency Amplification (455Kc)

Germanium PNP Mesa Type Transistor

2SA299	For Mixer & Local Oscillator Service (TV Tuner)
2SA230	For High Frequency Amplification (TV Tuner)
2SA239	For Converter Service (VHF•FM)
2SA240	For High Frequency Amplification (VHF-FM)

Germanium Point Contact Diode

1N60	For AM/FM Radio & Video Detector Service
1S50	For AM/FM Radio Detector Service (Single End)
1S34	For General Service

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TOKYO SHIBAURA ELECTRIC CO., LTD.

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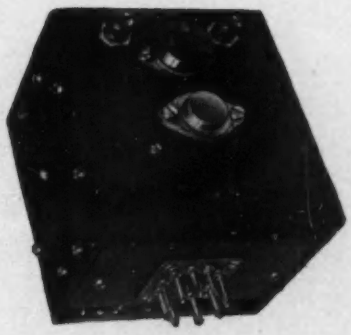
6 REASONS FOR CALLING BELIX *(ELMbridge 9118)*

- **Advanced circuitry**
- **First class mechanical design**
- **Fully guaranteed**
- **High stability components**
- **Top quality finishes**
- **Rigorous Inspection**

Less than 4½" cube, this new BELIX 1 amp Plug-in Power Supply Sub-Unit TSS 300 PA is typical of the ever-expanding BELIX range of rack-mounting, bench and sub-unit power supplies. It has a voltage range of 0.5v to 24v in 0.5v steps, stabilisation ratio of better than 1000 : 1 for 7% mains, and a d.c. source resistance less than 10 milliohms.



belix

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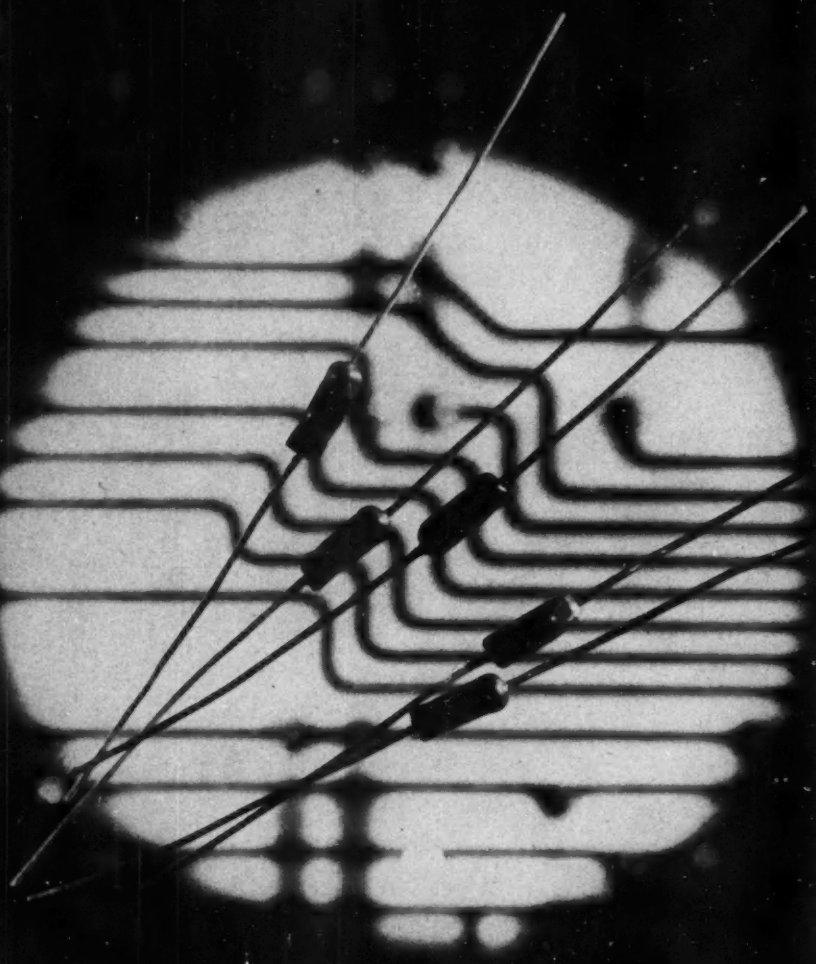
AEI focus on . . .
MINIATURE ZENER DIODES



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★ LOW CURRENT DRAIN
★ SMALL SIZE AND LOW WEIGHT
★ PREFERRED VOLTAGE TYPES
★ DOUBLE-ENDED ALL-GLASS CONSTRUCTION
★ HERMETIC SEAL

For COMPUTERS, DATA PROCESSING, INSTRUMENTATION, CLIPPING CIRCUITS, GENERAL VOLTAGE LIMITING and similar applications.

ADVANCE INFORMATION

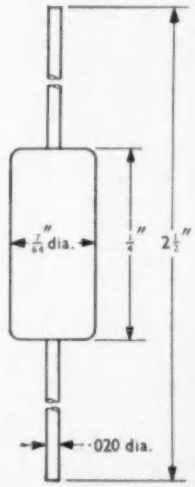
FEATURES—common to all these AEI Miniature Zener Diode Types

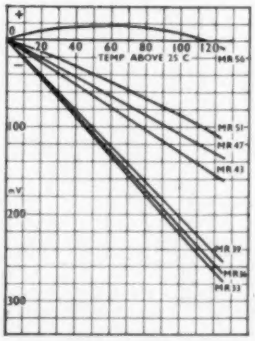
All glass encapsulation with sub-miniature construction . . . Hermetic sealing enables these diodes to be used in a wide range of environmental conditions . . . Rigidity of assembly and small size enable all types to withstand severe mechanical vibration and shock.

Diode Type	Zener voltage at 5 mA 25°C			Dynamic Slope resistance at 5 mA 25°C		Leakage current at 2V 100°C		Maximum Continuous Reverse current at 25°C mA
	Min. V	Typ. V	Max. V	Typ. Ohm	Max. Ohm	Typ. μA	Max. μA	
MR 33 H	3·1	3·3	3·5	90	100	250	600	50
MR 36 H	3·4	3·6	3·8	86	95	80	200	47
MR 39 H	3·7	3·9	4·1	80	90	35	100	44
MR 43 H	4·0	4·3	4·5	72	85	13	50	42
MR 47 H	4·4	4·7	5·0	62	80	3·0	30	40
MR 51 H	4·8	5·1	5·4	50	70	1·0	30	38
MR 56 H	5·3	5·6	6·0	28	50	0·6	10	35
MR 62 H	5·8	6·2	6·6	10	30	0·4	10	33
MR 68 H	6·4	6·8	7·2	3·7	15	0·85	10	29
MR 75 H	7·1	7·5	7·9	4·0	15	1·25	10	27
MR 82 H	7·7	8·2	8·7	5·5	20	1·5	10	25
MR 91 H	8·6	9·1	9·6	8·0	20	2·0	10	23
MR 100 H	9·4	10·0	10·6	11·0	30	2·0	10	21

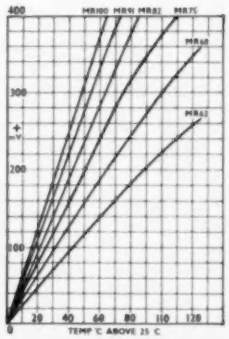
All above types	Forward volt Drop at 5 mA			Typical forward Slope resistance at 5 mA	Capacitance at −2 volts			Maximum Continuous forward current at 25°C mA
	Min. V	Typ. V	Max. V	ohms	Min. pF	Typ. pF	Max. pF	
	0·67	0·71	0·73	6·3	100	275	700	225

DIMENSIONS similar for all types





Typical change in reference voltage at 5 mA with temperature



Typical change in reference voltage at 5 mA with temperature

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TYPE	P.I.V. VOLTS	RECTIFIED OUTPUT CURRENT (mA D.C.)		MAXIMUM LEAKAGE CURRENT AT RATED P.I.V. (μA D.C.)		MAXIMUM FORWARD VOLT DROP AT RATED CURRENT	OPERATING TEMP. RANGE °C.
		AT 25°C	AT 100°C	AT 25°C	AT 100°C	AT 25°C volts	
1N2373	500	250	100	10	100	1.0	
1N2374	1000	250	100	10	100	2.5	
1N2375	1500	200	100	10	100	3.5	
1N2376	2000	200	100	10	100	6.0	−55 to +150°C
1N2379	4000	100	50	10	100	12.0	
1N2380	6000	100	50	10	100	18.0	
1N2381	10000	75	25	10	100	30.0	
1N2381A	12500	75	25	10	100	30.0	

1N 1130
1N 1131

1N 2373
to
1N 2381A

All illustrations ½ actual size.

H.V. SILICON RECTIFIERS
1·0 to 16·0 kV

1N1762	16000	285 (oil cooled)	170	25	150	60.0	−55 to +150°C
IC5	5000	75	50†	20	300	15.0	0 to +100°C
IC10	10000	60	40†	20	300	30.0	
1N1130*	1500	300	230	50	150	3.5	−65 to +150°C
1N1131*	1500	300	230	50	150	3.5	

Ratings given for Resistive/Inductive loads
* On 2" x 2" x 1/16" aluminium fin.
† At 75°C.

INTERNATIONAL RECTIFIER COMPANY

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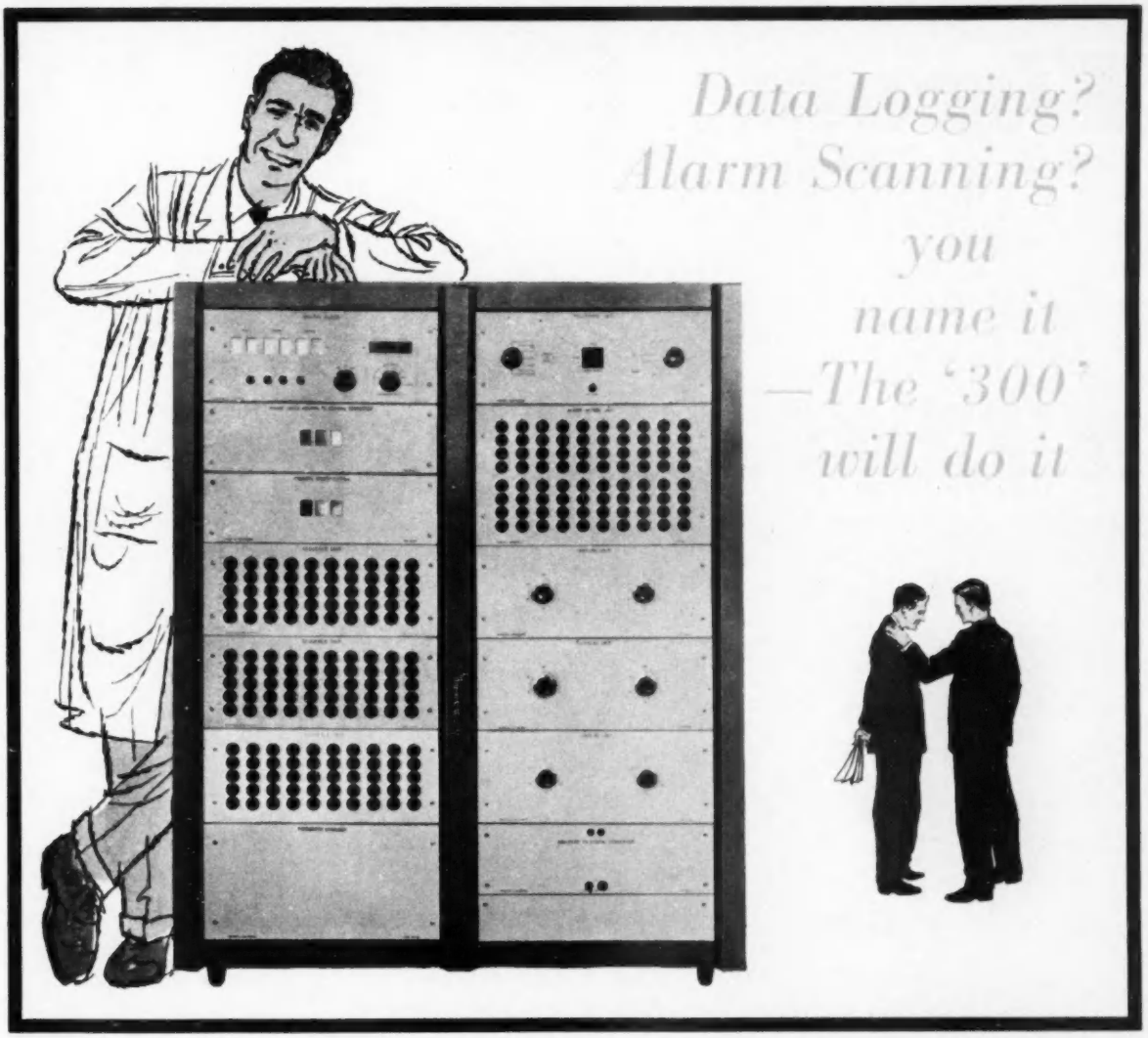
Associate company of International Rectifier Corporation U.S.A. and the Metal Industries Group, Great Britain.



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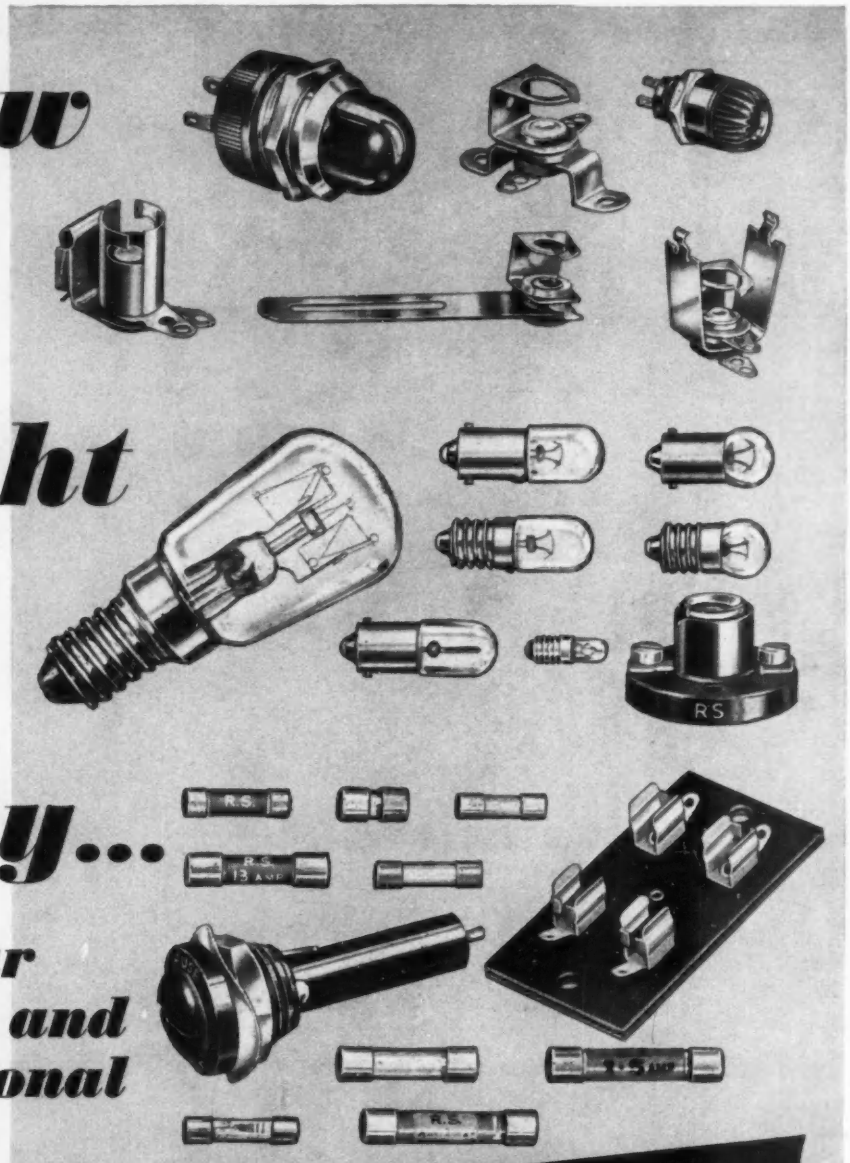

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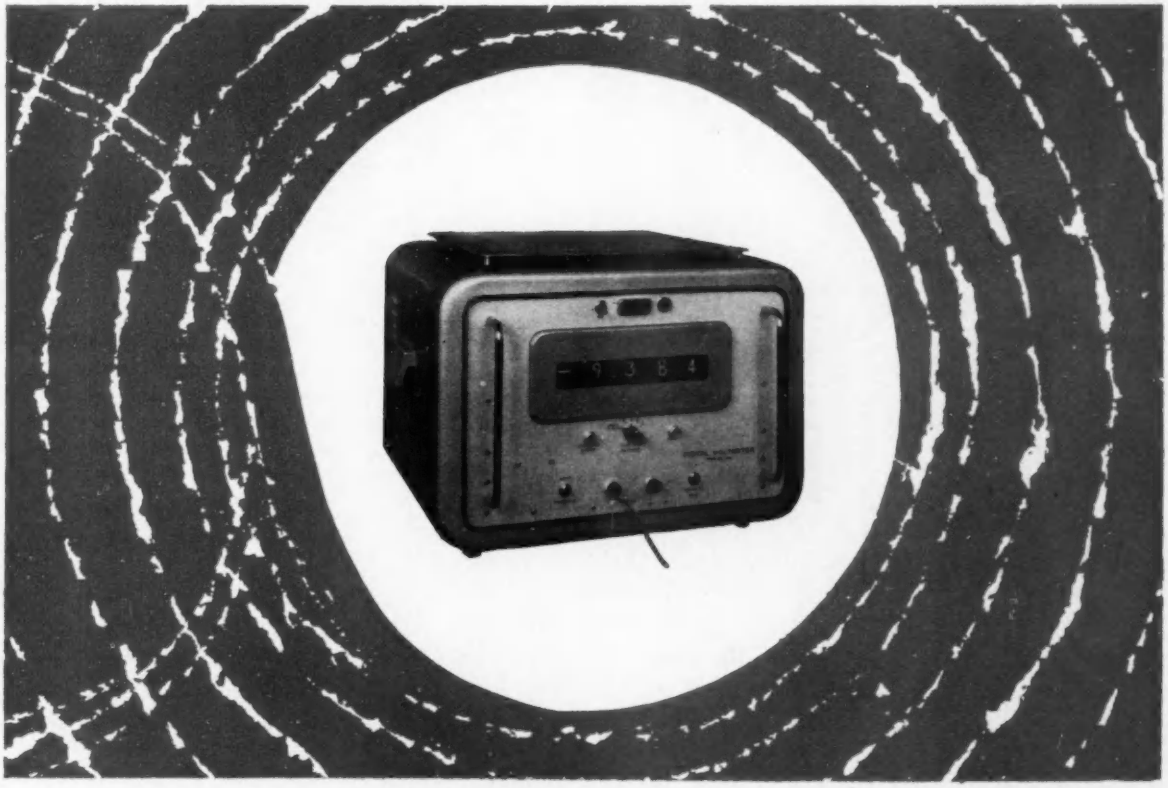
DIGITAL VOLTMETER

TYPE BIE2114



This all-electronic digital voltmeter, using an entirely new counting tube, has been designed for application in fields requiring accurate measurements of D.C. voltages. These include computer inputs and outputs, reference supply measurements, strain gauge measurements, production testing of electronic and electrical components and industrial process control (e.g. analogue-to-digital conversion).

- Decimal in-line display
- All-electronic—new counting tube
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- Automatic range and sign selection with indication
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Type No.	Continuous ratings 25°C		Characteristics 25°C	
	Max. Reverse Volts	Max. Forward Current	Max. Volts Drop	Max. Reverse Current
HG5001	100	80 mA	.8 v @ 100mA	5μA @—50V
HG5002	70	80 mA	.8 v @ 100mA	5μA @—50V
HG5003	100	80 mA	.8 v @ 100mA	25μA @—50V
HG5004	70	80 mA	.8 v @ 100mA	25μA @—50V
HG5005	100	80 mA	.8 v @ 100mA	50μA @—50V
HG5006	70	80 mA	.8 v @ 100mA	50μA @—50V
HG5007	40	80 mA	.8 v @ 100mA	5μA @—30V
HG5008	40	80 mA	.8 v @ 100mA	25μA @—30V
HG5009	40	80 mA	.8 v @ 100mA	50μA @—30V

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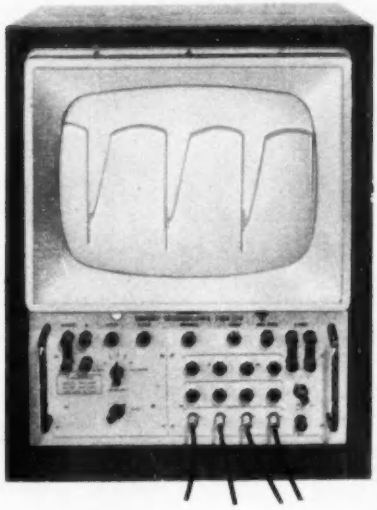
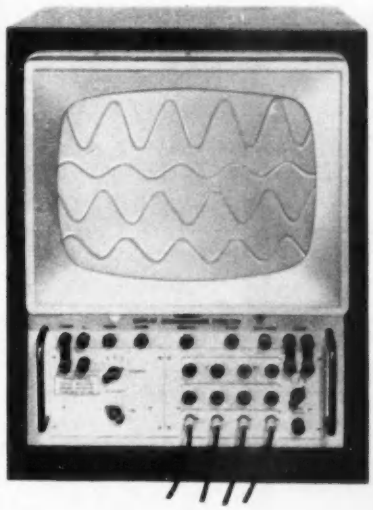
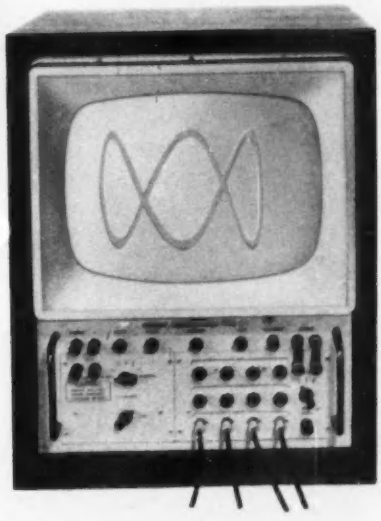


1 TRACE



2 or 4 TRACES

LISSAJOUS FIGURES



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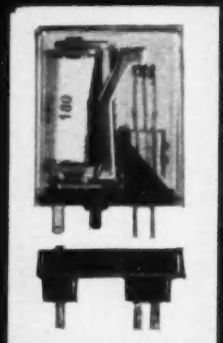
VP 2



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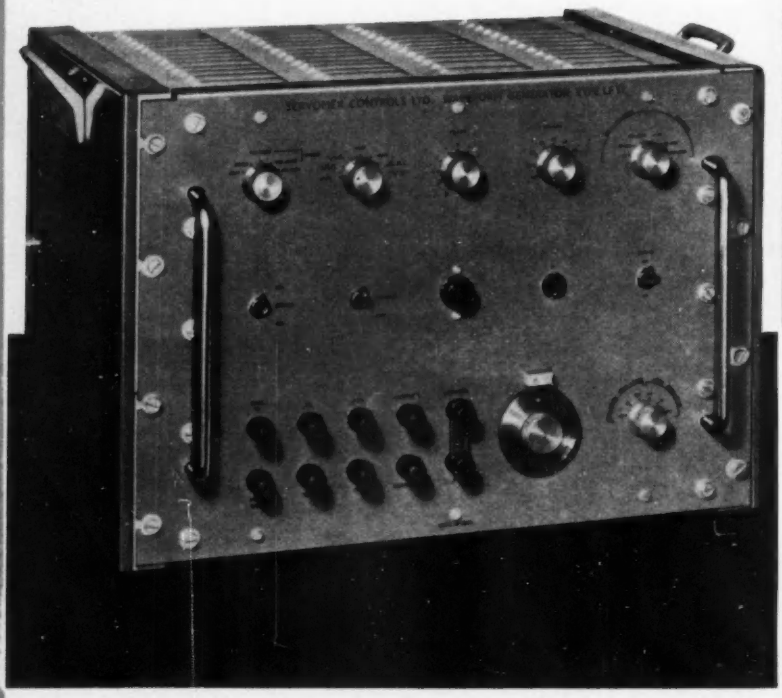
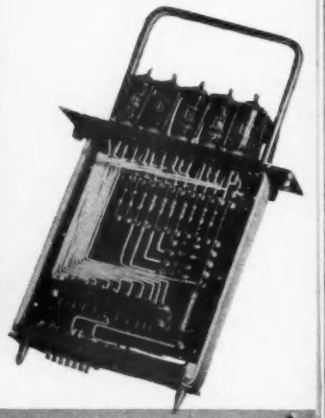
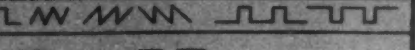
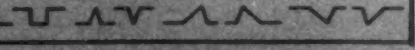




1. Selector switch at "CONTINUOUS"	
2. Selector switch at "SINGLE" - a step with continuously variable slope	
3. Selector switch at "DOUBLE" - a single isolated pulse in eight different forms	

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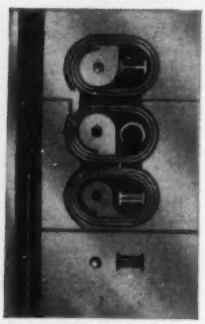

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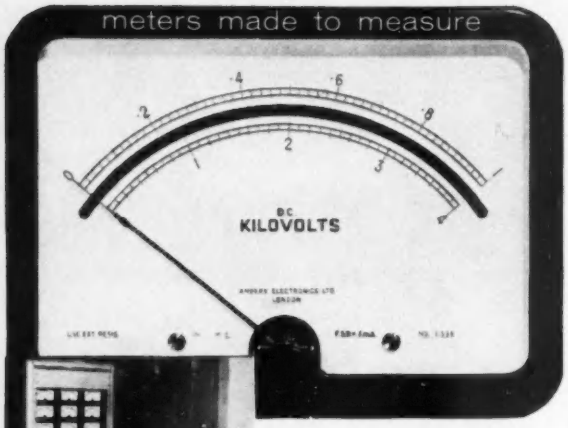

This Multi-range EHT Series 705 meter is one of a number of instruments supplied to the M.O. Valve Company Ltd. by Anders Electronics at very short notice. These meters are used in the M.O. Valve Company Production Test Equipment for Travelling Wave Tubes shown here. Just the kind of work Anders excel in : special meters for very special equipment. Anders are indebted to the M.O. Valve Company for their kind permission to illustrate this test gear.

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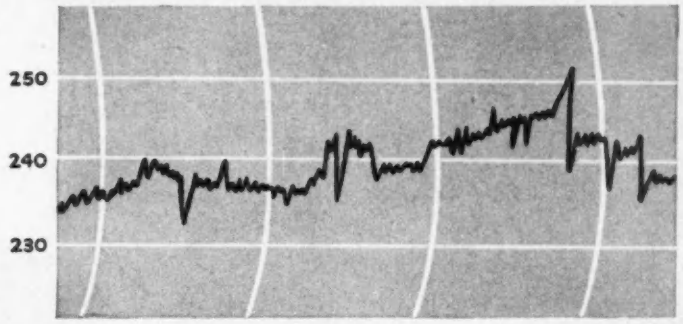
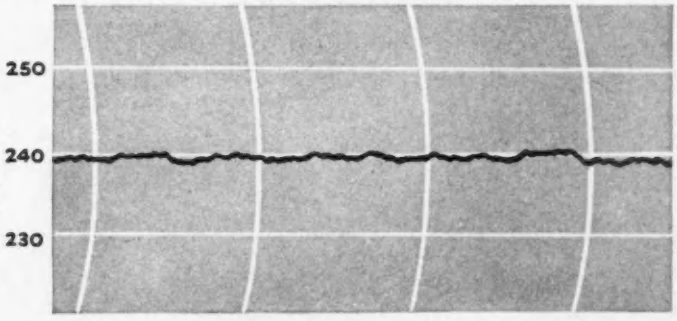
This recording is typical of line voltage conditions in an industrial establishment where voltage variation is a problem.

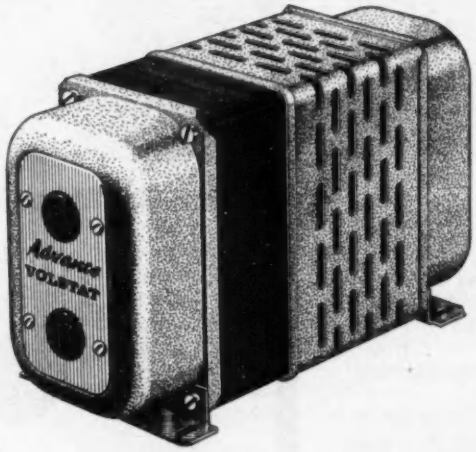


FLUCTUATING VOLTAGE



becomes constant with a

VOLSTAT



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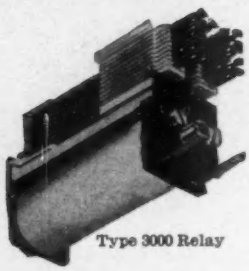

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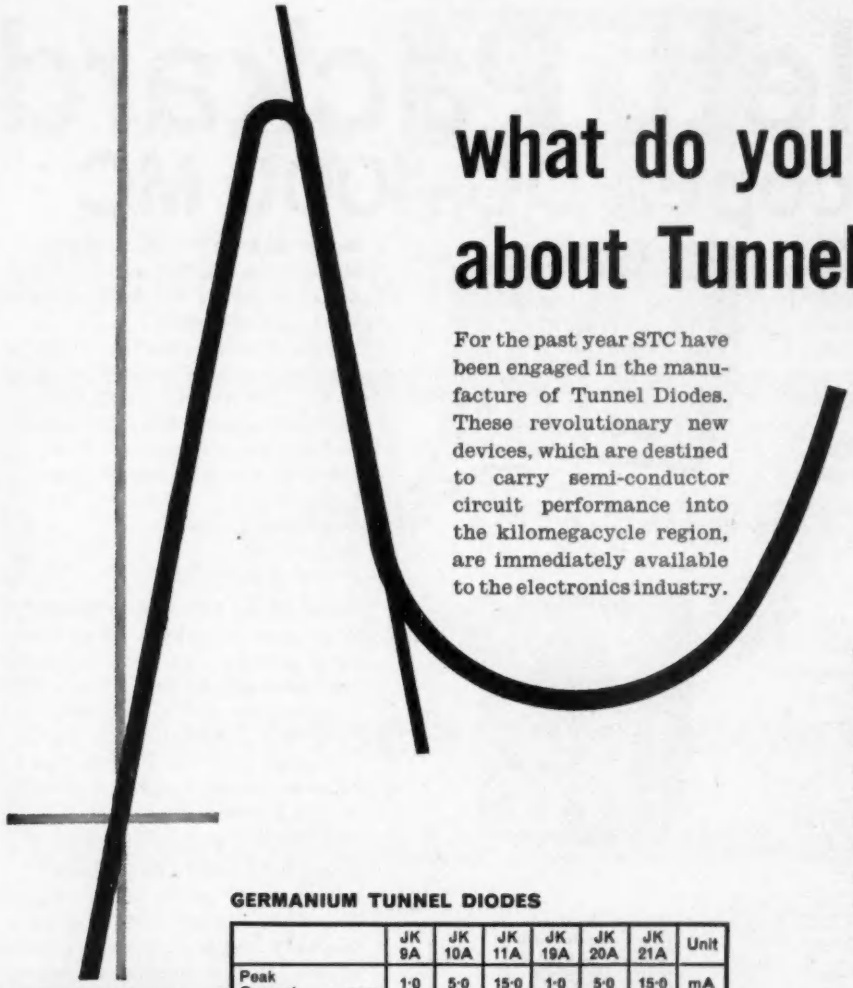
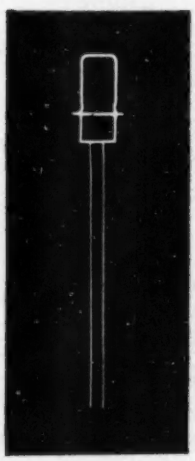




GERMANIUM TUNNEL DIODES

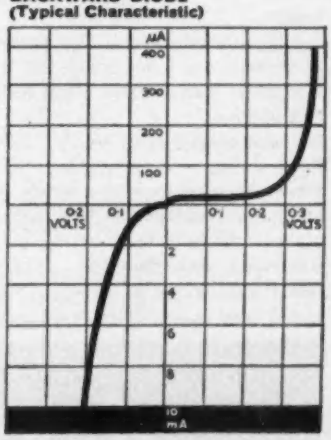
	JK 9A	JK 10A	JK 11A	JK 19A	JK 20A	JK 21A	Unit
Peak Current nom	1·0	5·0	15·0	1·0	5·0	15·0	mA
Current Ratio typ	4	4	4	6	6	6	
Junction Capacitance typ	25	50	125	10	40	80	pF
Resistive cut-off Frequency typ	540	810	810	1200	880	1100	Mc/s

BACKWARD DIODE

Typical Characteristics		Unit
Current in high resistance direction. (V_R = 200mV)	10	μA
Current in low resistance direction. (V_F = 200mV)	10	mA
Slope resistance. (V_F = 400mV)	1·1	Ω
Shunt capacitance. (V_R = 200mV)	90	pF

Tunnel diodes are finding many applications in digital computers, counting circuits and in high-frequency low-noise amplifiers. Backward diodes are being used for gating in tunnel diode circuits; as limiters; and their possibilities in core switching circuits are being explored.

BACKWARD DIODE
(Typical Characteristic)



Full details of these devices may be obtained on request from

COMPONENTS GROUP

61/6MK

Standard Telephones and Cables Limited

TRANSISTOR DIVISION: FOOTSCRAY · SIDCUP · KENT

EE 35 008 *for further details*

Hewlett-Packard
Oscilloscopes DC-1000 MC

Model 185 A/187 B – DC to 1000 MC
Completely new circuit approach permits viewing – on a bright 5"-cathode-ray tube – of repetitive short pulses requiring a bandwidth up to 1000 MC. Rise time of less than 0.45 millimicroseconds permits direct measurement and observation.
Sensitivity is 10 mV/cm to 200 mV/cm, horizontal sweep times 0.1 to 100 millimicroseconds/cm.
Price 185 A £ 800
187 B £ 400

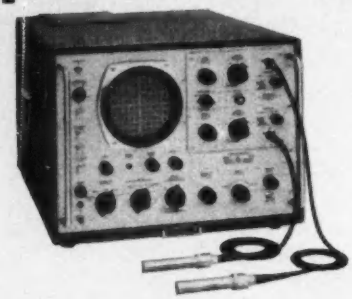


Photo 185 A

Model 150 A – DC to 10 MC
Broadly useful, high quality; has many plug-in amplifiers providing dual trace or differential input, voltage/current dual channel comparison, or high amplification eliminating preamplifiers between the oscilloscope and most transducers.
Sensitivity 200 mV/cm to 15 V/cm, horizontal sweep times 0.1 μsec/cm to 5 sec/cm.
Price 150 A £ 520
(Plus Plug-in Amplifiers)

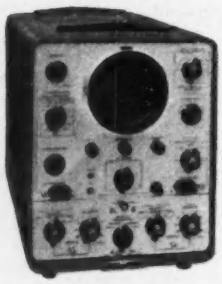


Photo 150 A

Model 130 B / BR* – DC to 300 KC
Highest quality, low-frequency oscilloscope. Includes universal automatic trigger.
Similar horizontal and vertical amplifiers with sensitivity 1 mV/cm to 125 V/cm.
Horizontal sweep times 1 μsec/cm to 12.5 sec/cm.
Includes times-5 magnifier.
Price £ 260

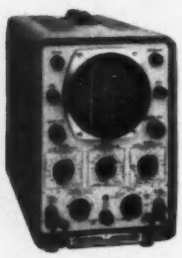


Photo 120 A

* Letter "R" indicates rack-mount instrument available.

Model 160 B / BR* – DC to 15 MC
Militarized instrument meeting U.S.A. military standards for shock, vibration, humidity, temperature.
Maximum vertical sensitivity 20 mV/cm, horizontal sensitivity 0.1 V/cm to 10 V/cm.
Horizontal sweep times 0.1 μsec/cm to 5 sec/cm in 24 ranges. Times 100 magnifier increases fastest sweep to 5 sec/cm.
Dual trace operation.
Price £ 740
(Plus Plug-in Amplifiers)

Model 122 A / AR* – DC to 200 KC
Dual trace, moderately priced instrument presents two separate traces simultaneously, or single trace when desired. Twin vertical amplifiers.
Sensitivity 10 mV/cm to 100 V/cm, sweeps 5 μsec/cm to 200 μsec/cm; expander extends range to 1 μsec/cm.
Universal automatic trigger.
Price £ 270

Model 120 A / AR* – DC to 200 KC
Industrial and production as well as laboratory instrument. Has universal automatic trigger, automatic synchronization on any internal or external voltage.
Sweep speeds 5 μsec/cm to 0.5 sec/cm, times-5 sweep expander,
high sensitivity calibrated vertical amplifiers.
Regulated power supplies; steady, drift-free traces, ideal for photography.
Price £ 180

Many world-famous Hewlett-Packard laboratory instruments are now made in the new Hewlett-Packard GmbH plant at Böblingen, near Stuttgart. Here quality engineering and latest manufacturing techniques bring you instruments of exceptional performance at moderate price.

Prices delivered U. K. exclusive of duty where payable. Continuous progress in design may affect the above specifications which are therefore subject to change without notice. For information, technical sales and engineering help, or a demonstration please write or call

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STC

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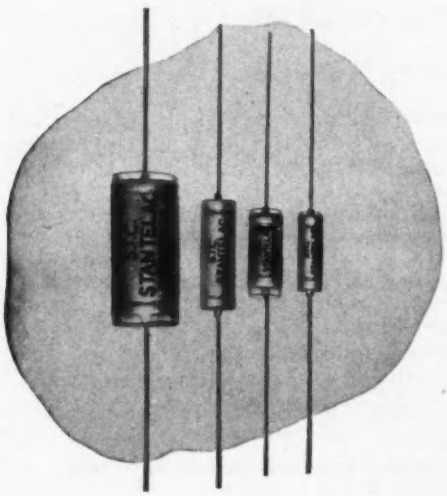
COATED FOIL CAPACITORS

a new development in Capacitor manufacturing techniques



EXCELLENT ELECTRICAL CHARACTERISTICS

HIGH STABILITY PERFORMANCE

SMALL PHYSICAL SIZE

LOW WORKING VOLTAGES FOR TRANSISTOR CIRCUITS

TEMPERATURE RANGE −40°C TO +70°C. H.I. CLIMATIC PROTECTION

CAPACITANCE RANGE 0·01μF TO 2·2μF

Send for details of the Stantelac range of capacitors and life test performance —

STC COMPONENTS GROUP

61/4MC

Standard Telephones and Cables Limited

CAPACITOR DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON

THE *FIRST* FULLY TRANSISTORIZED BATTERY-PORTABLE OSCILLOSCOPE

with full specification - high performance

Weighing only 13½ lbs., the new Tektronix Type 321 is by far the most portable oscilloscope obtainable — and yet is built to the high performance specification of a full-size instrument. Truly "go-anywhere" the Type 321 can be used in aircraft, ship, car; where mains connections are difficult or power fluctuations troublesome; where hum pick-up is a problem; or where it is desirable to isolate the instrument from earth.

TRULY PORTABLE

Battery Powered.
Weighs only 13½ lbs. without batteries.
Batteries weigh 2 to 4 lbs.
Size only 5¾" x 8¾" x 16".

HIGH PERFORMANCE

Vertical Response: DC to 5 MC, 0.07 μsec risetime.
Calibrated Sensitivity: 0.01 v/div to 20 v/div in 11 calibrated steps. Continuously adjustable from 0.01 v/div to 50 v/div.
Calibrated Sweeps: 0.5 μsec/div to 0.5 sec/div in 19 calibrated steps.
Accurate 5x magnifier extends calibrated range to 0.1 μsec/div. Continuously adjustable from 0.1 μsec/div to 1 sec/div.
Simplified Triggering: fully automatic, or amplitude-level selection with pre-set stability control.
4-kV Accelerating Potential on 3" crt.
6-div by 10 div Display Area (¼" div.)
Amplitude Calibrator.

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Operates from:—
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2. Ten rechargeable cells, 2.5AH — 5 hours continuous operation.
3. 11.5 to 35v dc (aircraft, car, boat etc.)
4. 105 to 125v ac or 210 to 250v ac, 50 to 800 cps.

Full details of Tektronix Equipment from sole representatives in Great Britain

LIVINGSTON LABORATORIES LTD
31 CAMDEN ROAD - LONDON - NW1
Telephone : Gulliver 8501 (10 lines)

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SenTerCel RS3 and RS5 silicon power diodes and rectifier stacks

RS3 Diode
ONE AMP 50 volts to 400 volts C.W.V.
RS5 Diode
FIVE AMP 50 volts to 400 volts C.W.V.
● Available from production
● High Efficiency
● Small Size
● High Temperature Operation
● Hermetically Sealed

Rectifier Stacks

The design of SenTerCel Silicon Rectifier Stacks offers many advantages including small size, low weight and higher ambient operating temperatures (up to 100°C). At present, silicon stacks are supplied with half-wave, bridge or push-pull connections for either single-phase or three-phase inputs. The great variety of possible series and parallel connections between diodes provides an extensive range of voltage and current outputs.

Write for STC silicon rectifier technical literature:

STC COMPONENTS GROUP

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RECTIFIER DIVISION: EDINBURGH WAY · HARLOW · ESSEX

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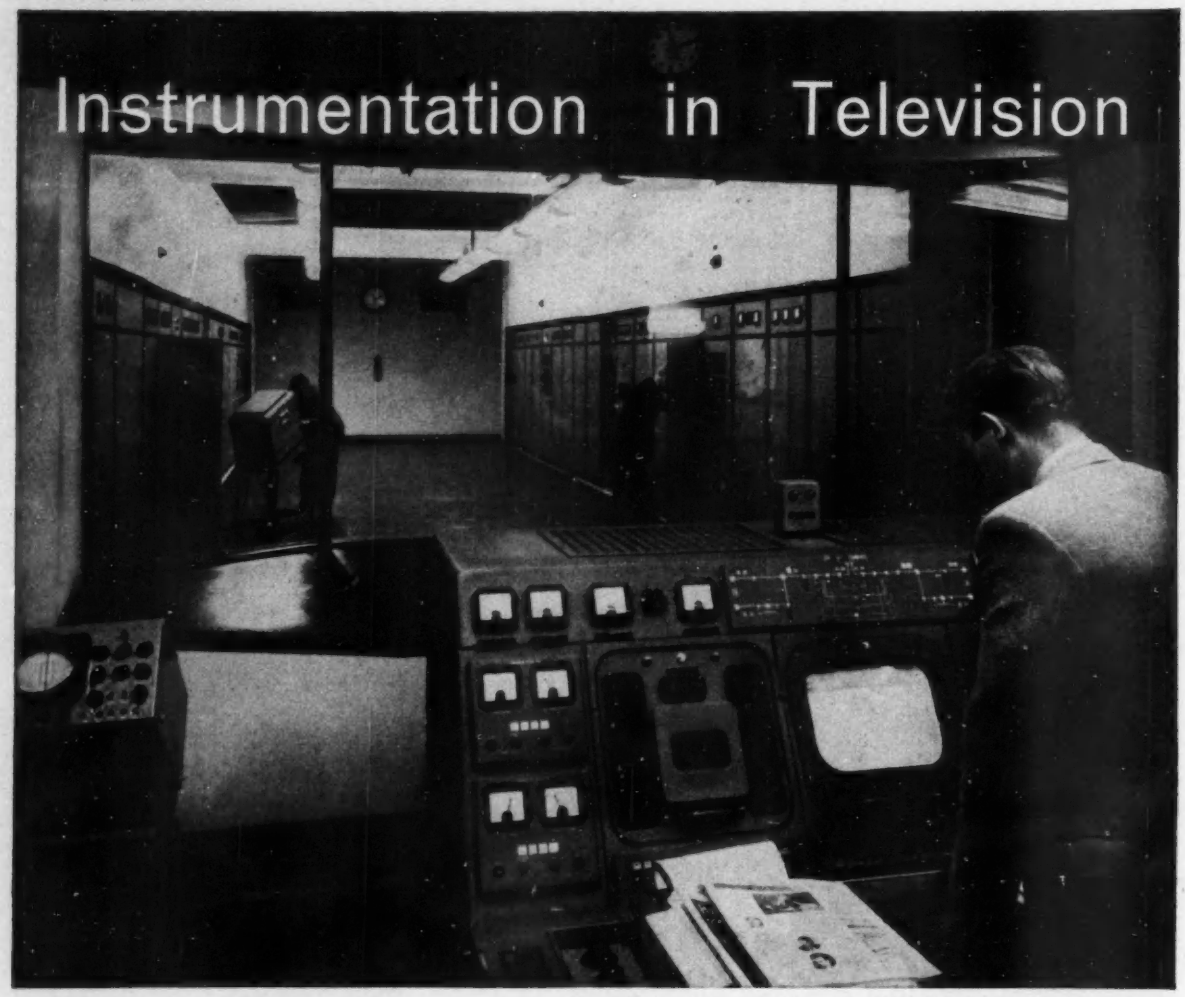
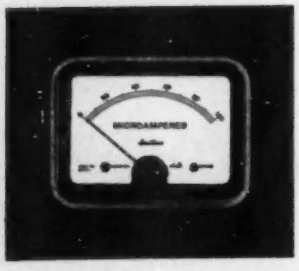
Instrumentation in Television



Ernest Turner instrumentation at the BBC Television transmitter, London.

Ernest Turner electrical measuring instruments represent the highest standards of design accuracy and workmanship. Clean lines, easily-read scales and attractive appearance combine with technical quality to present precision and industrial grade instrumentation in a wide variety of types, ranges and dimensions.

Full details of all Ernest Turner instruments are given in Catalogue No. 85, available upon request.



Ernest Turner

ELECTRICAL INSTRUMENTS LTD

HIGH WYCOMBE · BUCKINGHAMSHIRE · ENGLAND

EE 35 093 *for further details*

90 dB
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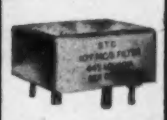

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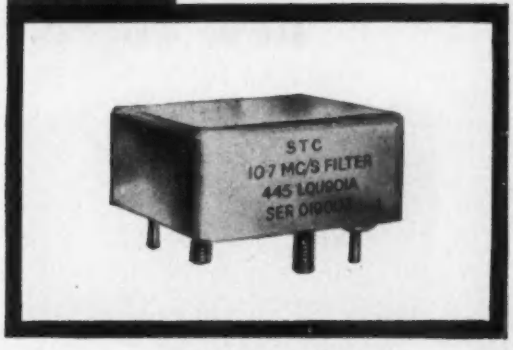
HIGH FREQUENCY CRYSTAL FILTERS



For 50 k/cs, 25 k/cs, 12·5 k/cs
Channel Spacing in VHF Equipments

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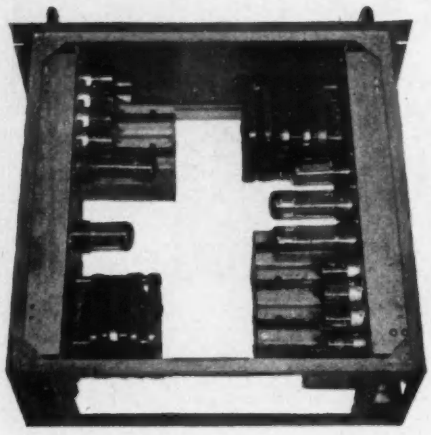
regulated - well ventilated - power supplies



Improved Brandenburg design, with wide centre ventilation and easier access to all components. Two of model V300/200 mounted in one suitable frame measuring 17½″×17½″×7″. This shows one of many methods of mounting these units

All models voltage stabilized.

polarity	reversible
effective resistance	0·1 ohm
stability	against + or − 10% mains change: 0·02%
ripple	less than 2mV
input	200/250 volts, 50 cycles.
output a.c.	100 and 200 mA models: 4×6·3V, 1·5A. 350 and 500 mA models: 2×6·3V, 5A. All can be paralleled
dimensions	100 and 200 mA models: 15¾″×5¾″×6¼″ high. 350 mA models: 15¾″×7⅛″×7⅛″ high. 500 mA models: two chassis, each 15¾″×5¾″×6¼″ high. Flanged open chassis, with frames available for converting all models to front panel mounting

All prices quoted are for U.K. only—ex-works

200-350 V.		200-350 V.	
100 m/A.	£37 10 0	1 Amp.	£140 0 0
200 m/A.	£48 10 0	2 Amp.	£230 0 0
350 m/A.	£64 0 0	complete with 19″ front panel and assembly	
500 m/A.	£80 0 0		

Models below 200 volts can be supplied to order.

new current-stabilized models

type C300

input	200/250 volts, 50 cycles
output current	50-300 m/A, continuously variable
output voltage	500 volts, maximum
stability	better than 0·1% for + or − 7% mains variation
drift	less than 0·5% for 30 minutes

enquiries are invited for similar specifications

Brochure of Brandenburg voltage-stabilized range also available

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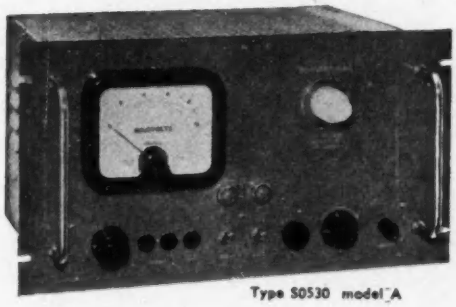
BRANDENBURG LIMITED

139 Sanderstead Road, South Croydon, Surrey. SANderstead 3555/6

Export enquiries should now be directed to Brandenburg Limited at the above address

high voltage regulated power supplies —standard models up to 100 kV.

5, 10, 20 and 30 kilovolt regulated supply



Type S0530 model A

All prices quoted are for U.K. only

Type S0530

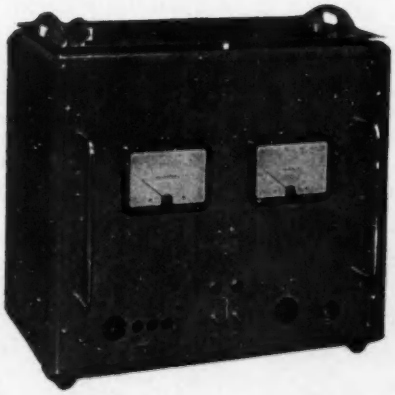
output	1 to 10 kV at 2mA. Model A 2 to 20 kV at 1 mA. Model B 3 to 30 kV at ½ mA. Model C 500 V to 5 kV at 2 mA. Model D
input	200/250 volts, 50 cycles
polarity	positive or negative grounded available
regulation	against full load: better than 0.5% Against mains variations of plus or minus 7%, better than 1%

- 5" Ernest Turner movement
- current metering jack
- standard 19" x 10½" P.O. panel
- for rack mounting or bench use

£135 ex-works

Models A, B and C can be supplied with reversible output polarity at £165

50 kilovolt regulated supply



Type MR50R

Type MR50R

output	5 kV to 50 kV at 1 mA
input	200/250 volts
polarity	reversible
regulation	against full load: better than 1% Against mains variations of plus or minus 7%, better than 1%
dimensions	W: 24" H:23" D: 15"

£245 ex-works

100 kilovolt regulated power supply

Type MR100R

output	10 to 100 kilovolts, continuously variable, at 1 mA
polarity	reversible
ripple	0.1%
regulation	no load to full load: better than 1%. Against mains variations of plus or minus 7%, better than 1%
input	200/250 volts, 50 cycles
metering	output voltage and current metered

£525 ex-works

Brochure on request : for further specifications of this Brandenburg range of standard high voltage equipment, please write for brochure.

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Minimum space....

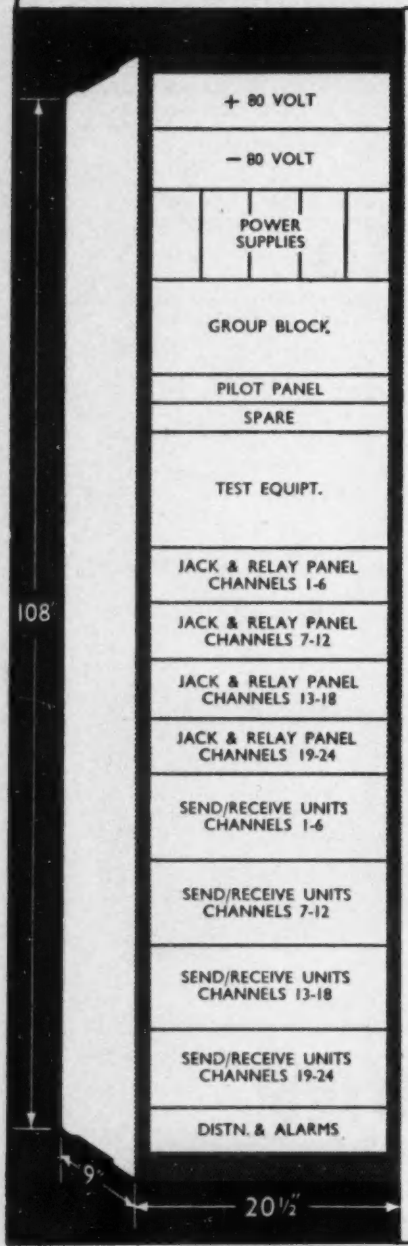
Minimum power consumption....

Minimum maintenance....

AEI Transistorised FMVFT

TYPE CT 24A

FOR THE PROVISION OF TELEPRINTER OR DATA TRANSMISSION CIRCUITS

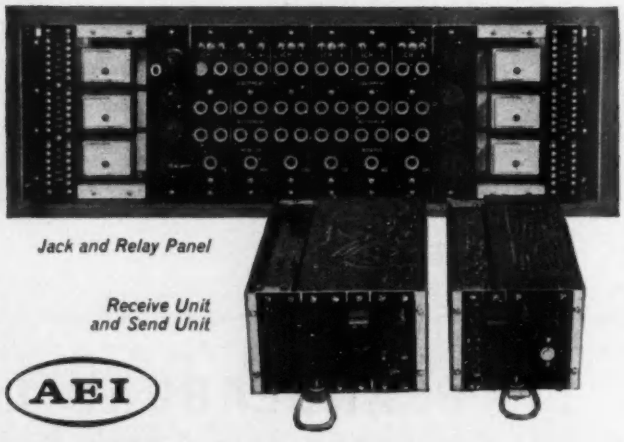


- CCITT standards of performance
- 24 channels per rackside
- 50 baud nominal, with operation up to 80 bauds
- Plug-in units
- Optional in-built test equipment comprising:—
  - a) Telegraph test set
  - b) Level measuring set
  - c) Frequency check unit
- Completely self contained with all power supplies
- Pilot facility 300 c/s or 3300 c/s

24 frequency modulated channels are provided in the nominal frequency band 420-3180 c/s with 120 c/s separation between adjacent channels. These are built up from 4 sub-groups of 6 channels each in the frequency band 1140-1740 c/s. Compactly assembled plug-in units use printed circuit wiring boards with small encapsulated filter and transformer units. Equipment is protected by bay covers, but test equipment and jackfields are directly accessible at centre of rack.

Bearer Band	300-3400 c/s
Deviation	± 30 c/s from mid frequency
Send level range	–15 to –35 dBm
Receive level range	–15 to –35 dBm
DC lines	Send 20mA double current. Receive up to 100 mA. Balanced loop and neutral loop conditions on request.
Temperature compensated	+ 5°C to + 55°C
Power supplies	100-120v or 200-240v AC (Battery operation through an inverter as optional extra).

Details of the latest AEI Carrier Telephone and Telegraph Equipment supplied on request



Jack and Relay Panel

Receive Unit and Send Unit

AEI

Associated Electrical Industries Ltd

Telecommunications Division, Transmission Department
Woolwich, London S.E.18, England

Cables: Sieswan London

PD 8/9

AINTREE

Both you and the racing driver would agree that all circuits have their own characteristics and problems . . . . .

but for *you*, when selecting a valve for all round optimum performance . . . . .
better make it BRIMAR

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"SCALAMP" DOUBLE-REFLECTION GALVANOMETERS

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"SCALAMP" MEGOHM-PER-VOLT D.C. VOLTMETER

A portable instrument giving all the advantages of a sensitive valve voltmeter but without zero drift. Ten ranges give full scale readings of 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V. Full scale current drain only 1 μA.

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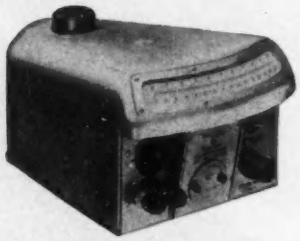

40kV ELECTROSTATIC VOLTMETER

Direct reading up to 40kV d.c. or r.m.s. a.c. regardless of waveform. Negligible leakage. Rapid response. Accuracy ± 2%.

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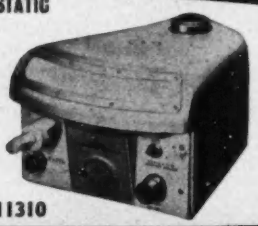
"SCALAMP" ELECTROSTATIC VOLTMETERS

Three instruments with ranges of 1 to 5, 3 to 10 and 5 to 18kV d.c. and 1 to 5, 3 to 10 and 5 to 12kV r.m.s. a.c. Negligible leakage. Accuracy ± 2%.



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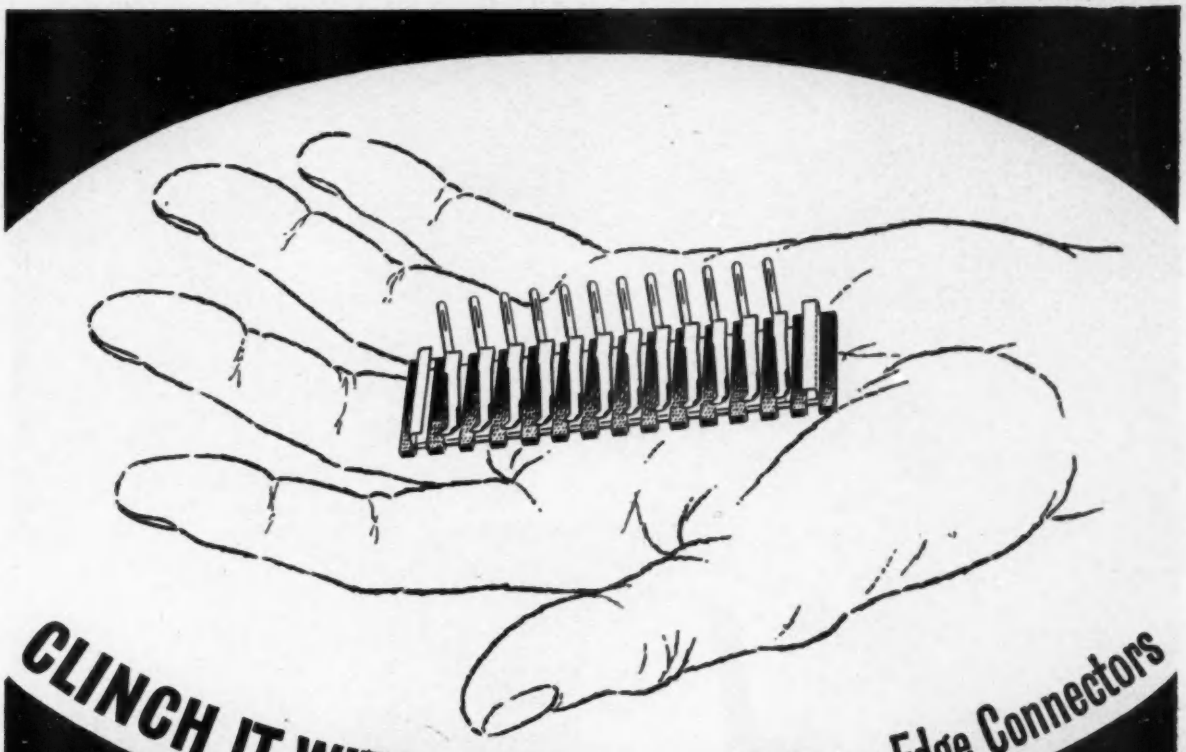


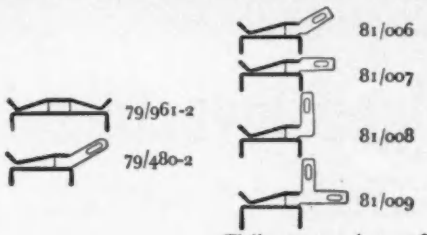
CLINCH IT WITH CINCH Printed Wiring Edge Connectors

FAST, LOW COST ASSEMBLY

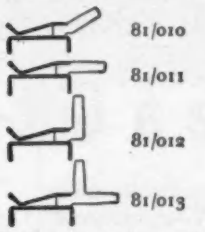
SPECIFICATION

AVAILABLE IN: Any no. of ways up to 40.
CENTRES: 0.150" or 0.156" as specified.
CURRENT RATING: 5 Amps per contact.
WORKING VOLTAGE: 500 V.D.C.
VOLTAGE PROOF: 2 K.V/D.C.
CONTACT RESISTANCE: <5 m Ω after 1,000 sizings and exposure to DEF.5000 tropical conditions.
WITHDRAWAL FORCE: 4 to 6.5 ozs. per Contact.

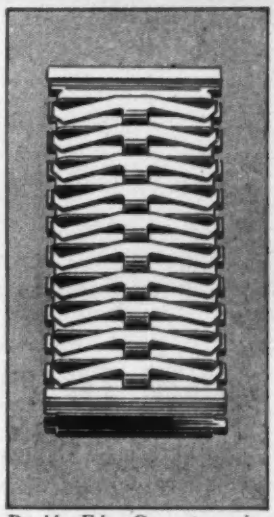
CONTACTS: Phosphor Bronze, finished Gold Plate on Silver, Silver or E.T.
Note: 79/480-2 & 79/961-2 Brass only; finish as above.
LAMINATE: Best quality Commercial Grade Grade II; Fibreglass to order. (Fibreglass 0.150" ctrs. only).
END GUIDES: Hard Brass; finish as above.



Tails accept Amp 98 Taper Tab



Tails accept Amp 78 Taper Tab.



Double Edge Connector using 79/961-2 Contacts

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Phone: Sandiacre 3085. Telex 37637

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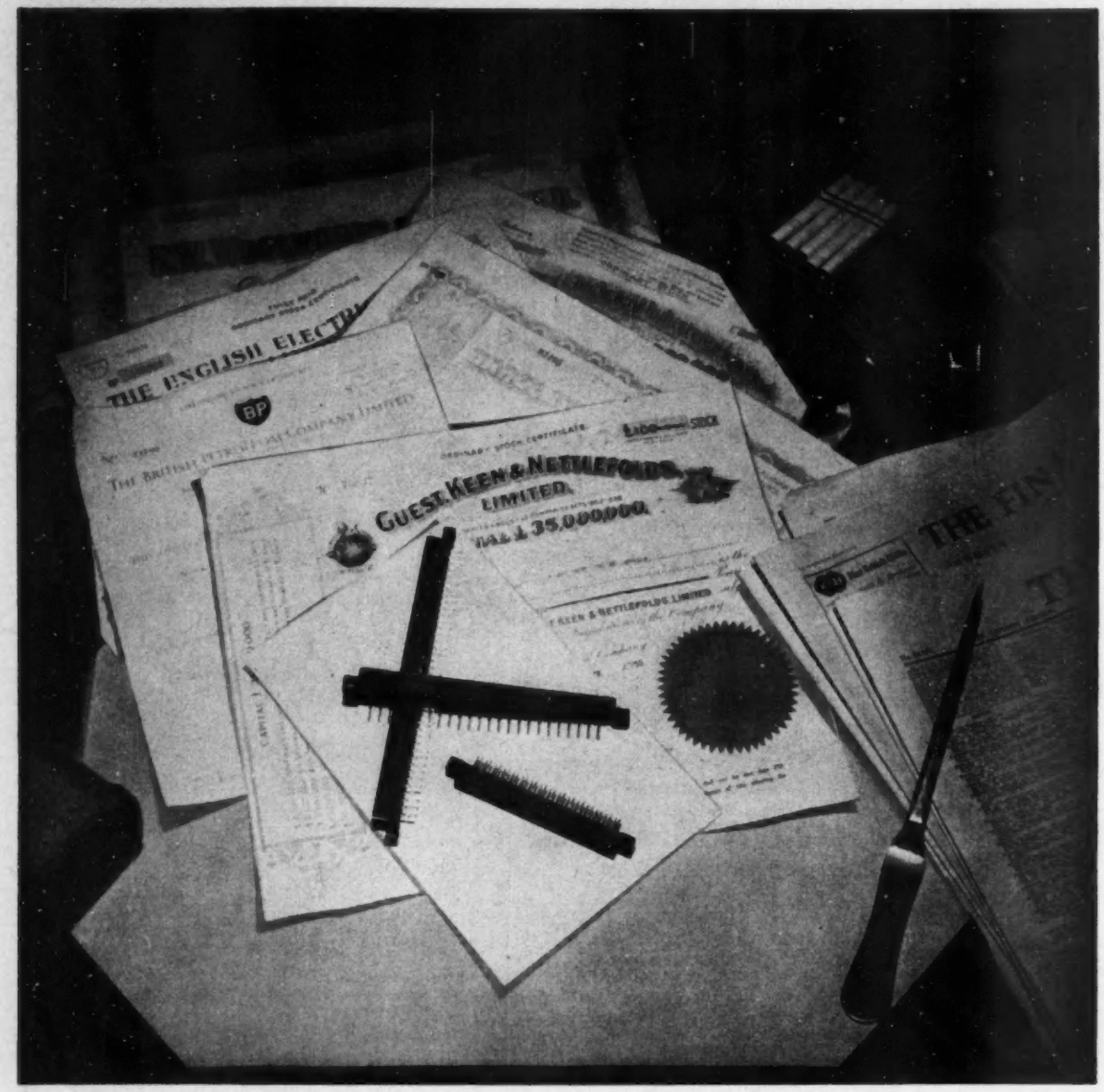

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0.150	0.062	8, 16, 24, 32 & 40	0.200	0.062	16, 32, 48 & 64
0.156	0.062	6, 10, 12, 15, 18, 22 & 27	0.200	0.093	48 & 56
0.200	0.062	4, 8, 12 & 16 (0.100 with alternate contact omitted)	*Many other types are available*		
			SPECIAL DESIGN		
			0.150	0.062	10&32 single-sided & 20 double-sided
0.200	0.062	8, 19, 24 & 32			
0.200	0.093	24 & 28	0.156	0.062	36 ways double

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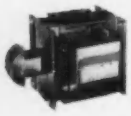
A robust unit with a sheet steel cover. Fixing feet at either top or throat of the solenoid as required. Pull type only from 10 lb. continuous rating to 20 lb. short rating. 2" maximum stroke.



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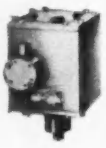
Cylindrical body. Capable of 1 in. lb., continuously rated; 10 in. lb., short rated. Pull or Thrust Type. Voltage Limits 6-440.

SERIES C
A heavy duty solenoid capable of 110 in. lb., continuously rated; 600 in. lb., short rated. Pull or Thrust Type Voltage Limits 110-500.



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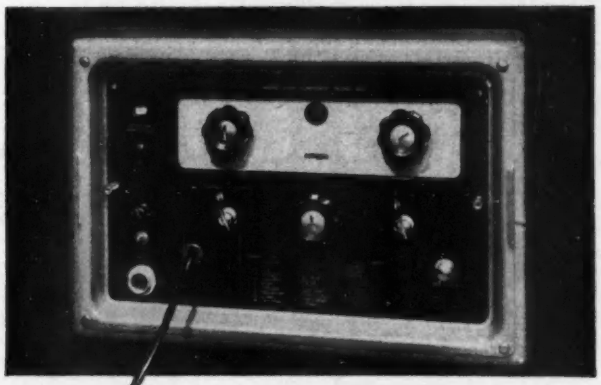

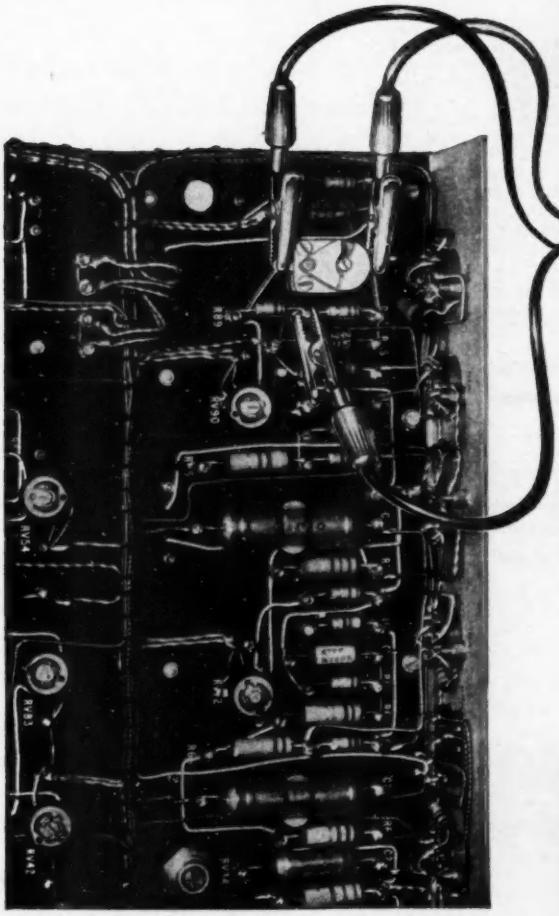

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Component Bridge B521

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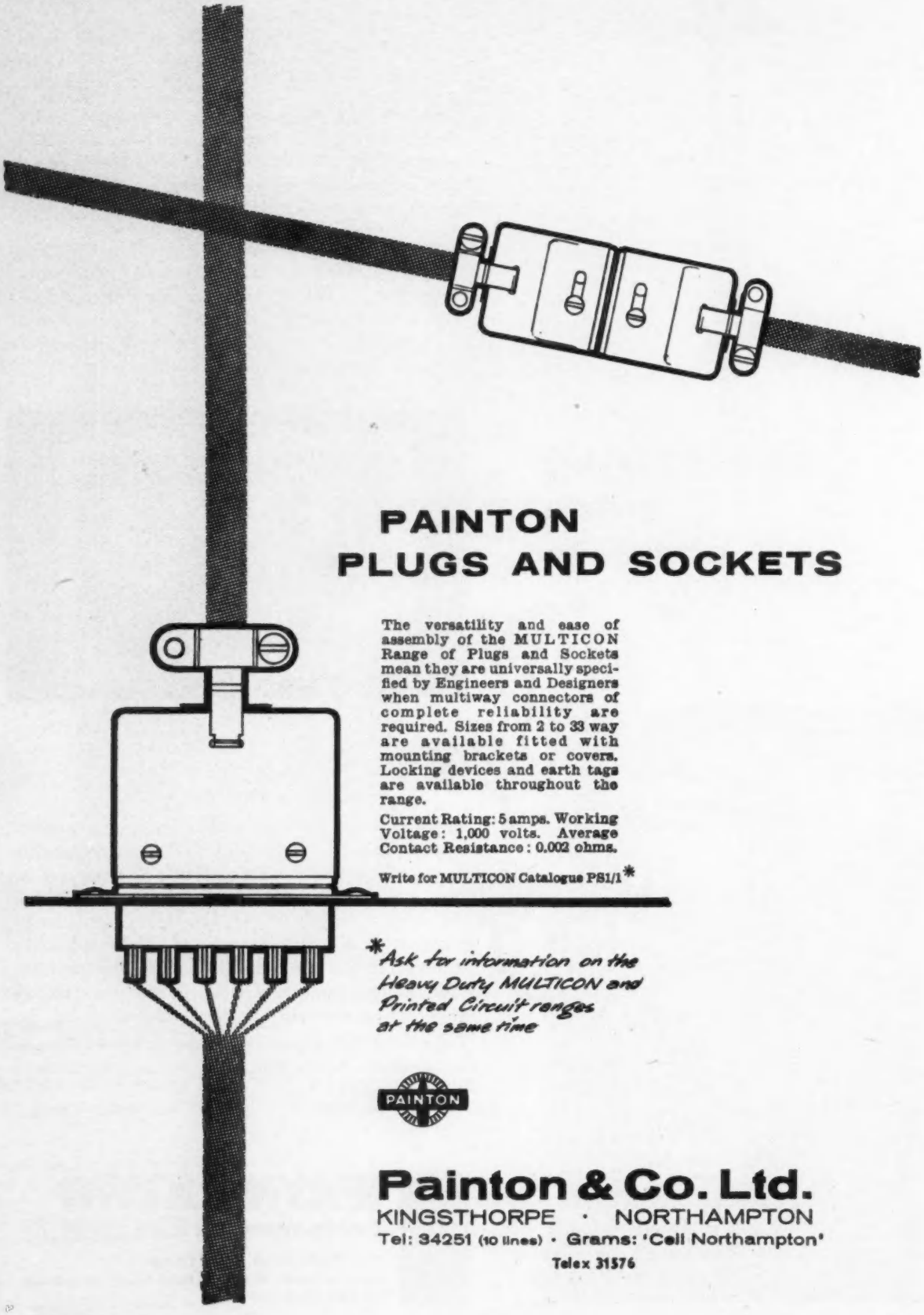

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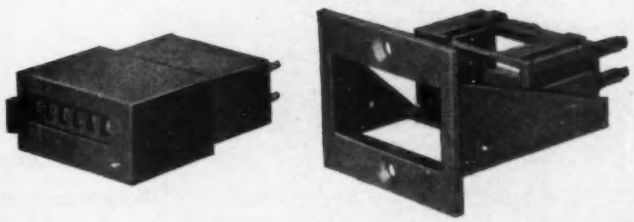

Flexibility shown by plug-in flush mounting and dovetailed stack

The Hengstler Series F.43 electro-magnetic counter (patents pending) is manufactured in Western Germany by J. Hengstler K.G., Sole agents for this counter in the U.K. are

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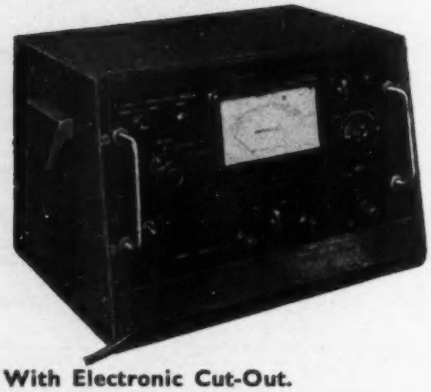

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Maximum Output Current:	5 amps continuous.
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Inexpensive open chassis model

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Output Current: 1 amp maximum.
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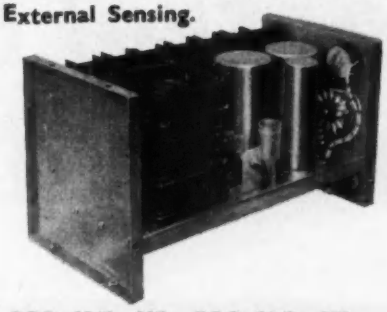
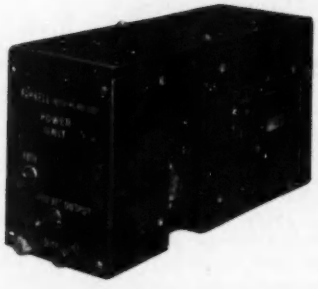
Maximum Output Current: 5 amps continuous at 18-30 volts.

Also available PSO 18/2, (0-18v at 2a) PSO 12/5 (0-12v at 5a) PSO 30/2 (18-30v at 2a).



Prices of other Models (U.K. only)—PSO 18/2, £44. PSO 12/5, £65. PSO 30/2, £53.



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Transistorised Power Supply Unit

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D.C. Output: 0-5 volts D.C. and continuously variable.
Output Current: 5 amps continuous.
Dimensions: 21½″ long × 16″ deep × 12″ high.

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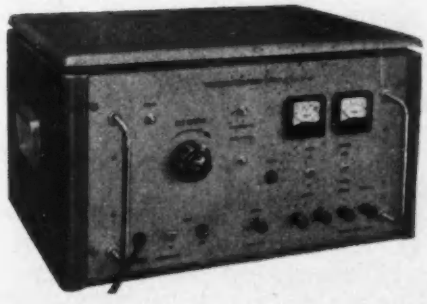

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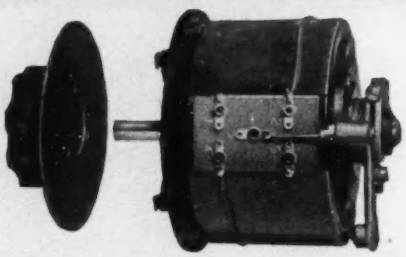

'Torovolt' toroidally wound continuously variable auto-transformer. Enables smooth adjustment of A.C. voltages from zero to 20% in excess of supply.

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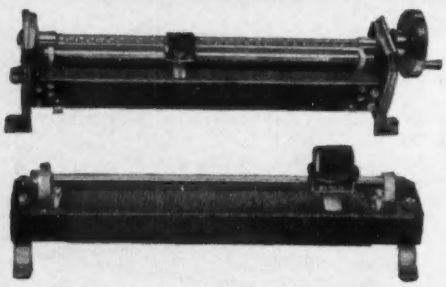

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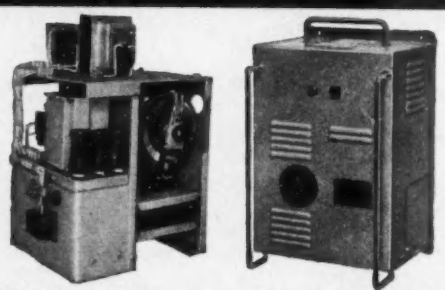

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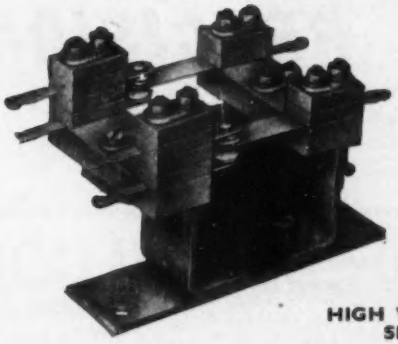

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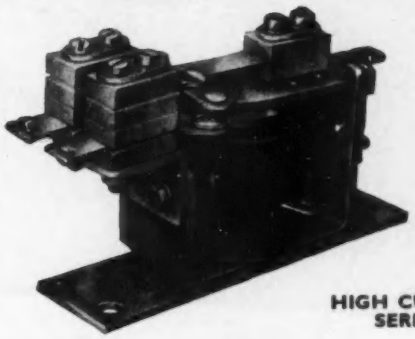

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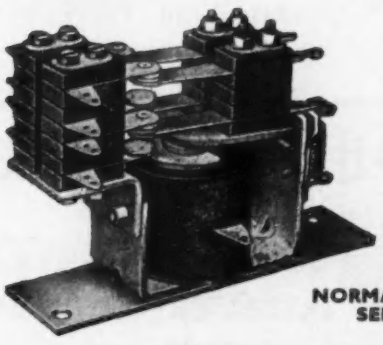

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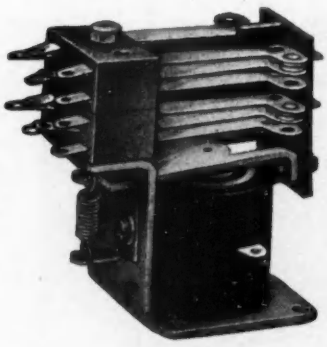

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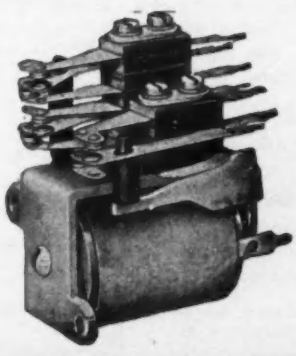

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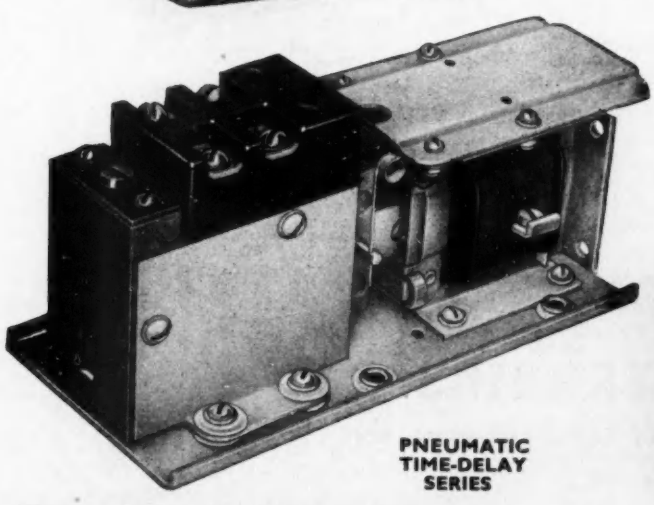

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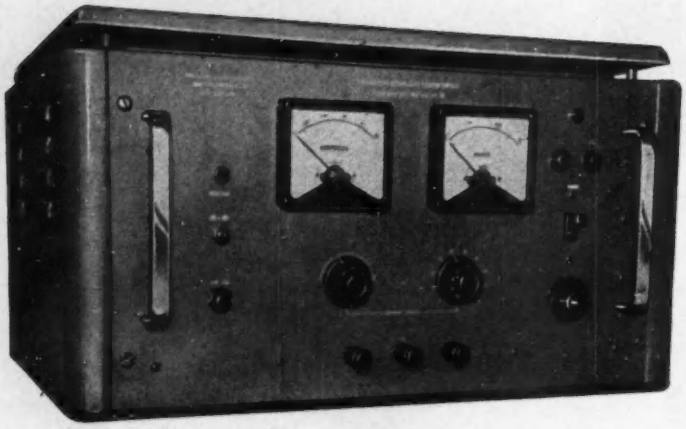

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AT 10 AMPS. FULLY REGULATED

Output resistance:	0.01 ohm.
Stabilisation:	1000 : 1
Ripple:	1mV. peak to peak
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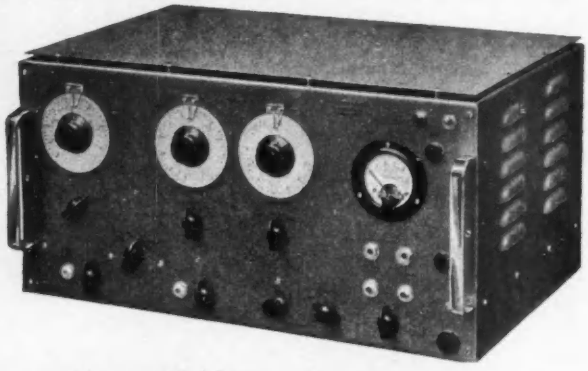
PULSE GENERATOR

TYPE 302A

GENERAL PURPOSE

LABORATORY INSTRUMENT



½ amp. peak current available in output 0 to 100 volts continuously variable output. Fully Regulated Internal D.C. supplies. Rise Times of 0.015 μS. Low output impedance. Extremely small jitter.

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Oscillator frequency:	10 c/s to 10 Mc/s.
Delay:	0.3μs. to 10 ms.
Pulse Width:	0.1μs. to 10 ms.
Pulse amplitude: (positive or negative)	0 to 30 volts into 75 ohms· 0 to 100 volts into 1,000 ohms.
Square waves:	10 c/s to 1 Mc/s.

The instrument can be synchronized or triggered from an external source.

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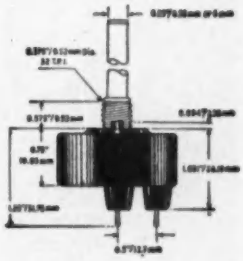
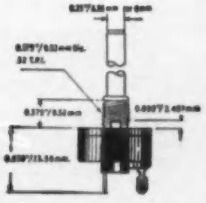
TYPE 'H'

robust, fully sealed—type approved for RCS.112A RCC. 122 patterns RVC3 and 4. Stock values from 500 ohms to 2·5M power rating 1½ watts, maximum working voltage 750 D.C.
Body diameter 1·562 inches



TYPE 'LH'

fully sealed miniature version of Type H. RCSC Type approved to patterns RVC1 and 2.
Stock values from 500 ohms to 3M, power rating ½ watt, maximum working voltage 750 D.C.
Body diameter 0·969 inches



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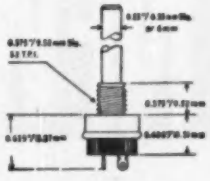

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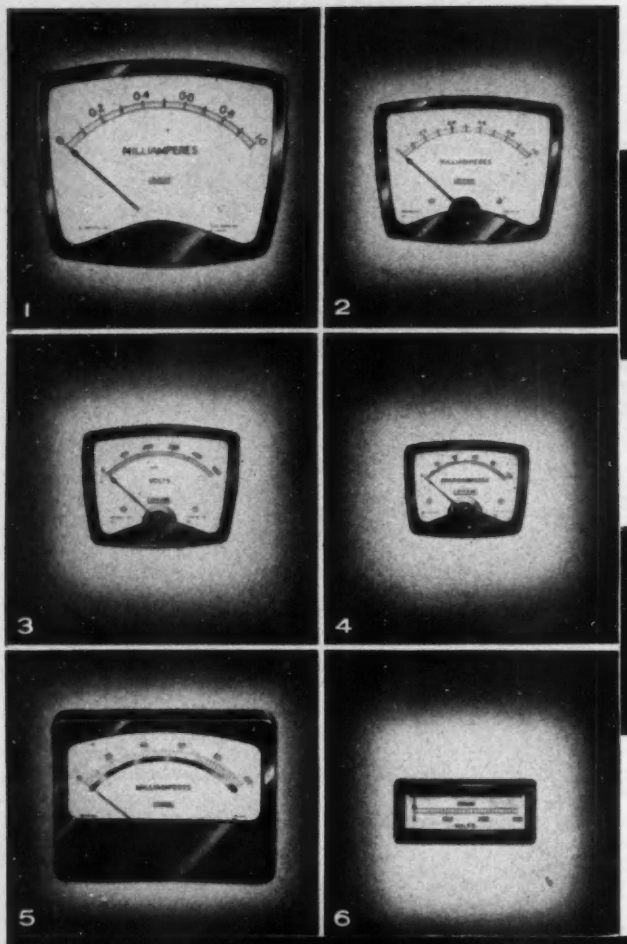

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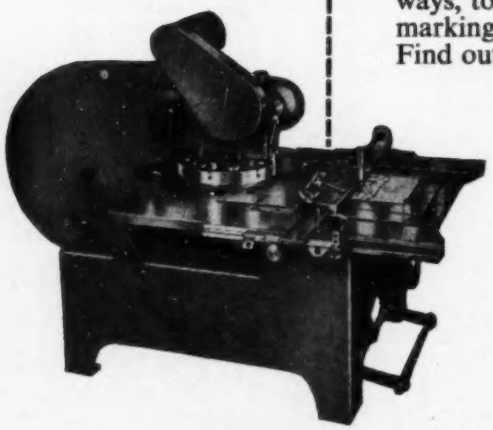

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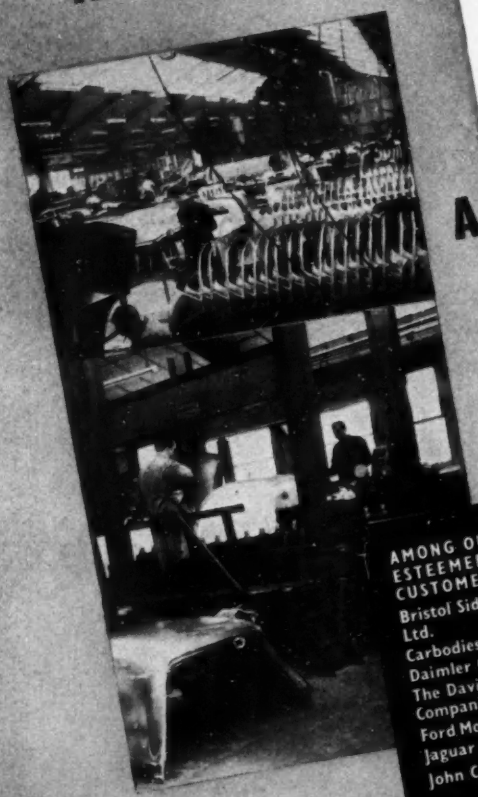

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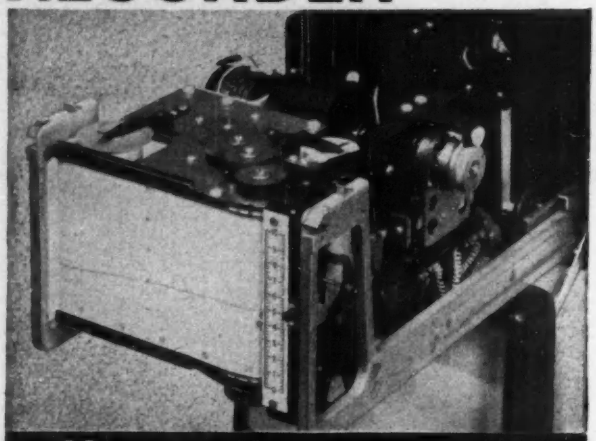

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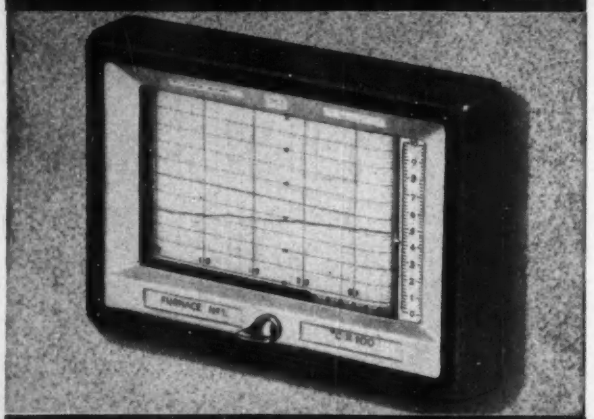

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ELECTRONIC ENGINEERING

VOL. 33 No. 401

JULY 1961

Commentary

THE 'Radio and Electronic Component Show' took place at Olympia, London, from 30 May to 2 June and a selection of the exhibits is described elsewhere in this issue.

This Exhibition, which was the first of its kind to be held at Olympia was the successor to the RECMF Exhibition which has been such an eagerly anticipated and well attended annual event in the years since the war. This year's exhibition, naturally, was devoid of the intimate atmosphere of its predecessors which were held at the Grosvenor House Hotel but it undoubtedly had other compensations to offer. The space available was vastly greater, which not only allowed the exhibition to be more comprehensive but also permitted viewing in greater comfort. It was, in fact, the largest exhibition of radio and electronic components ever to be staged in Europe and the attendance during the four days of the show was over 35 000 persons, while more than 2 500 overseas buyers from 56 countries did business there.

The main theme of the exhibition was twofold: reliability and miniaturization—two aspects of modern design which in many applications are all important and which are frequently entwined.

Reliability in electronic components always, of course, has been a prime aim but usually a compromise has had to be made between the characteristics and the cost, including development cost, of any particular component. For many purposes cost is still of major importance but the widespread use of electronics under more arduous and exacting conditions in industry, aircraft and missiles for instance has tended to introduce a new philosophy into the design of components.

It may be somewhat trite to remark that a chain is as strong as its weakest link but it is nevertheless true and it is equally so when applied to electronic equipment. It is of no matter how elegant and sophisticated the circuits may be or how well the equipment is constructed; if one vital component breaks down the equipment will cease to function correctly. In the days when the main pre-occupation of electronic engineers was the provision of domestic entertainment, reliability, though important for the good name of the manufacturer, was a comparatively minor aspect of design. If the failure of a component caused the listener to miss the climax of an Agatha Christie thriller or the punch line of a joke it was, no doubt, frustrating and annoying but the disappointment was short lived and no great harm was done. The position today is very different. The failure of a vital component in a piece of electronic equipment may mean the shutting-down of a steel-rolling mill, a chemical plant or that an underwater telephone cable has to be recovered for repair. Failures and stoppages of this kind may well be measured in terms of thousands of pounds per hour. In other applications, such as aircraft and missiles, a component failure may be not only expensive but catastrophic in terms of human lives.

This then is the background to the present day emphasis on reliability and the reason why large sums of money and considerable manpower are expended in an endeavour to attain the goal of complete reliability. The quest for this is not, however, a matter which is of benefit to only a small class of professional equipment for it ultimately confers its benefits on even the cheapest classes of domestic equipment. The cycle of evolution is usually as follows. In the first place a component will be produced to meet a specialized requirement, frequently for the armed services, and this will take place on an almost literally money no object basis; once the initial development has been sponsored it is frequently possible to produce the component at a price which makes it attractive for professional and industrial purposes and this is the second phase. Once a component is in limited production it is usually possible to complete the third stage which consists of streamlining and mechanizing the manufacturing processes which thus provides a superior component at a price which makes it suitable for use in domestic and general purpose equipment. An example of this process is to be found in switch contacts where the evolution of new methods of precious metal plating is producing switches with gold plated contacts at a price which makes possible their inclusion in standard television receivers. This relationship between the specialized high price component and its general purpose counterpart may be linked to that existing between the racing car and the family saloon where, for example, a few years ago disk brakes were developed at great cost for racing cars and where today they are available for general use at a price which is almost comparable to that for standard drum brakes.

The other main theme at the Exhibition was miniaturization and here the cycle of evolution is similar to that outlined for reliability. For a number of modern applications miniaturization is a necessity, but without doubt the greatest spur to this trend has been the advent of the transistor. It has been a two-headed spur (or a hayfork prod): the inherent small size of the transistor and its comparatively small heat dissipation. Encapsulated transistor amplifiers and oscillators are available already with component packing densities of the order of a quarter million per cubic foot while the continued development of solid state circuits is promising equivalent densities many times greater.

Based on the present state of our knowledge it would appear that this latter technique will afford the ultimate in miniaturization and it is indeed fortunate that in all probability it will also offer the ultimate in reliability.

Secondary Surveillance Radar

By D. H. R. Archer *, M.A.

In this article the principles and fundamental characteristics of secondary radar are discussed and some of the system design problems are set forth. The various methods of suppressing sidelobe interrogation are dealt with at some length. The use of the system as a data transmission link is dealt with together with the possibilities of system expansion and future trends.

(Part 1)

(Voir page 473 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 481)

SECONDARY radar is the name given to a system of radiolocation which depends for its operation, not, as does primary radar, upon the reflection of a radiated signal from a remote object, but upon the existence, at the remote point, of a receiver-transmitter which responds, automatically and with a known delay, to a signal radiated from the locating station. In the standard nomenclature the transmitter at the locating station is called the 'interrogator', the receiver-transmitter at the remote point is usually called a 'transponder' and the receiver associated with the interrogator is called the 'responsor'. An automatic communication system has similar components: that which distinguishes secondary radar from other communication systems is the use of radar techniques to measure the interval between transmission and response and thus to determine the distance of the transponder from the interrogator-responsor.

The earliest applications of secondary radar were for military purposes during the Second World War. Two important developments were the 'H' systems which were used as bombing aids and, subsequently, for survey and reconnaissance work, and the i.f.f. systems for distinguishing friendly from hostile aircraft. In the first instance the aircraft carries an interrogator-responsor which is used by the aircrew to measure the distance of the aircraft from two transponders at known points, thereby determining the position of the aircraft (with a single ambiguity which is readily resolved in practice). In the second instance 'friendly' aircraft are equipped with transponders which respond with a recognizable signal when interrogated by 'friendly' defending forces. The system is principally used in association with primary radar and, to facilitate the identification of the secondary radar response with the primary radar echo, the two transmissions are customarily in a constant time relationship with each other. Indeed, in the early i.f.f. systems the primary radar transmission was used also as the secondary radar interrogation; such a practice is open to a number of objections, however, especially with microwave primary radars, and modern i.f.f. systems operate on frequencies separate from those of their associated primary radars.

Since the War, secondary radar systems have been developed or proposed for a variety of aviation, marine and meteorological applications. One of the most important of these is the international Secondary Surveillance Radar

* *Cossor Radar & Electronics Ltd.*

The above photograph shows a sidelobe suppression aerial mounted on a vehicle which contains the interrogator-responsor.

(S.S.R.) system for air traffic control. The possibility of using secondary radar to advantage in this way was considered by the group, formed at the Telecommunications Research Establishment (now the Royal Radar Establishment) at the end of the War, to study possible peacetime applications of wartime radar inventions. Proposals were made and some demonstrations were given[1] to the Provisional International Civil Aviation Organization (PICAO) in 1946. The proposals were not immediately followed up in this country, however, and a programme laid down in the U.S.A. was abandoned, before any significant work had been done, at the outbreak of the Korean war. There the matter rested until, in 1951, a development programme was initiated by Cossor in this country. Experimental ground and airborne equipment was constructed to meet a specification, the broad outlines of which had been agreed with the U.K. Ministry of Civil Aviation, and the system was tried successfully at London Airport using facilities provided by the Ministry. After several years of development and evaluation in the U.K. and the U.S.A. a system based on the original Cossor development was adopted by I.C.A.O. in 1957.

Fundamental Characteristics

It is appropriate at this point to consider some of the fundamental characteristics of secondary surveillance radar systems: thus providing the background against which the international developments which have taken place since these early trials should be viewed. It is convenient, too, to describe these characteristics in terms of the corresponding primary radar characteristics, starting with the range equation.

In a primary radar system, using a common transmit-receive aerial, the transmitted and received powers, the gain of the aerial, the distance of the target and its 'equivalent echoing area' or 'radar cross-section' are related by an equation of the form:

$$S_a = x \frac{P_a G_a^2 \sigma}{r^4} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where S_a is the received signal power

P_a is the radiated signal power

G_a is the gain of the transmitting-receiving aerial in the direction of the target

σ is the equivalent echoing area of the target

r is the range of the target

x is a constant (containing the square of the wavelength of the radiation, and having the dimensions of an area)

In a secondary radar system there are two transmission and reception phases. In the interrogation phase it is necessary, in order that the system shall operate, that a signal be received by the transponder of sufficient amplitude to trigger the responding circuits therein. Using notation similar to that above one may write:

$$S_t = y \frac{P_i G_i g_r}{r^2} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where S_t is the signal power received at the transponder

P_i is the signal power radiated by the interrogator

G_i is the gain of the interrogator aerial in the direction of the transponder

g_r is the gain of the airborne receiving aerial in the direction of the interrogator

y is a constant

Similarly, for the air-ground phase one may write:

$$S_r = z \frac{P_t g_t G_r}{r^2} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where S_r is the signal power received at the responsor

P_t is the signal power radiated by the transponder

g_t is the gain of the airborne transmitting aerial in the direction of the responsor

G_r is the gain of the responsor aerial in the direction of the transponder

z is a constant

Compatibility of Ground and Airborne Equipment

For a primary radar, the condition which must be satisfied if a target is to be 'seen' is:

$$S_a \geqslant s_a$$

where s_a is the minimum detectable signal.

For a secondary radar system, however, two conditions must be satisfied:

$$S_t \geqslant s_t \text{ and } S_r \geqslant s_r$$

where s_t and s_r are the minimum signals which can be detected by the transponder and responsor respectively. Thus, while for a primary radar the maximum range at which a given target can be detected by a radar of known characteristics can be specified by substituting s_a for S_a in equation (1), thus[2]:

$$r_{max} = \left(\frac{P_a G_a^2 \sigma x}{s_a} \right)^{\frac{1}{4}} \quad \ldots\ldots\ldots\ldots (4)$$

the maximum range of a secondary radar system under specified conditions and with an interrogator-responsor and transponder of known characteristics is given by whichever of the expressions:

$$\sqrt{\left(\frac{P_i G_i g_r y}{s_t} \right)} \text{ and } \sqrt{\left(\frac{P_t g_t G_r z}{s_r} \right)}$$

represents the smaller range. Ideally, the two expressions should be equal: if they differ substantially, either the transponder will at times be caused to transmit in reply to interrogations from a station which is too far away to detect the responses or it will be radiating a signal which can be received by other responsors over an unnecessarily wide area. Both conditions, for reasons which will become apparent, are undesirable.

The condition for equality of the two expressions is:

$$P_i/P_t \,.\, G_i/G_r \,.\, g_r/g_t \,.\, s_r/s_t = \text{constant} = z/y \quad \ldots\ldots (5)$$

and it may be assumed that for well-designed equipment P_i/P_t and s_r/s_t will remain substantially constant, under normal operating conditions, over quite long periods. In a surveillance system, too, it may be assumed that the gains G_i and G_r relate either to a common aerial assembly or to two assemblies, the rotations of which are synchronized and that the ratio of their values in the direction of interest will be constant. The same cannot be said of the airborne aerial gains g_r and g_t, however, unless the same aerial is used for receiving and transmitting and the radio frequencies used for interrogation and response are the same or very nearly so. To obtain reasonable directivity with interrogator-responsor aerials of moderate size these radio frequencies must be in the u.h.f. or s.h.f. bands and at these frequencies practical airborne aerials exhibit wide variations of gain with aspect. To ensure a high probability of detection at the maximum range for which the system is designed, the interrogator and transponder transmitters must deliver sufficient power to their aerials to produce a detectable signal at the remote point even when the aircraft is in its less favourable aspects: it may not be possible, however, to make allowance for the extreme shadowing

which may be encountered in some aspects. If the aerial position has been well chosen, the extent of these shadow zones will be quite small: if separate airborne receiving and transmitting aerials are used, however, the shadow zones, if any, of one aerial are unlikely to be coincident with those of the other: from a system point of view, therefore, they may be additive and thus result in a reduction of detection probability.

From this point of view, therefore, there can be seen an advantage in using a common airborne aerial for reception and transmission: other persuasive considerations are the difficulty of finding suitable places to put aerials on aircraft and the undesirability of carrying more aerials and feeders than are strictly necessary. If a common aerial is used, there are obvious advantages in using the same or similar radio frequencies for transmission and response: the frequencies cannot be the same, however, largely because of the danger of regenerative mutual interrogation between transponders. If they are very close together one may, with sufficient accuracy, write:

$$g_r \simeq g_t$$

for all aspects. Similarly, since it will be more convenient to use a common ground aerial for interrogation and response than to use two separate, highly directional aerials for marginally different radio frequencies:

$$G_t \simeq G_r \text{ and } y \simeq z$$

whence equation (5) reduces to:

$$P_t s_r \simeq P_r s_t \quad \ldots\ldots\ldots \quad (6)$$

The significance of equation (6), the approximate nature of which must be emphasized, is as a rough check of the compatability of an interrogator-responsor with a transponder: for example, if it is desired to associate with an existing long-range secondary radar system an interrogator-responsor to provide cover over a small area, failure to comply roughly with the requirements of equation (6) will result either in the interrogation of transponders whose replies cannot be detected by the responsor or in an unnecessary sensitivity of the responsor to responses by transponders to interrogation by other stations.

Primary Radar Interrogation

The adoption of similar frequencies for interrogation and reply channels rules out the possibility of using a primary radar as the interrogator of the system. The use of an existing transmitter and aerial system for this purpose, however, is superficially so attractive that it cannot lightly be set aside. At this stage it will suffice to mention four disadvantages of such an arrangement.

(1) The range of radio frequencies of the primary radars which might have to be used for the purpose extends from about 600Mc/s to about 10 000Mc/s. This makes the design of the airborne receiver and aerial system very difficult. At the higher frequencies the polar patterns of airborne aerials exhibit very large variations of gain with aspect and to obtain a reasonable total pattern for the full range of radio frequencies it may be necessary to equip the aircraft with several aerials.

(2) The range of signal power levels with which the transponder receiver may have to contend is very wide. The transponder may be expected to reply to signals which, after allowing for variations in airborne aerial gain, may vary some 80dB in power level.

(3) No selective coding can be introduced on the interrogation path.

(4) The transponder will reply to all primary radars, the radio frequencies of which are within the appropriate bands and which are within interrogation range whether they are associated with responsors or not.

These considerations, and some others which will be described later, have led system designers to reject the possibility of using primary radars an interrogators in an air traffic control secondary radar system.

Sidelobe Interrogation

A further disadvantage of using primary radars as interrogators is the difficulty of dealing adequately with the problem of interrogation by sidelobes of the primary radar aerial radiation pattern. The problem is not confined to primary radar interrogation: in no practical radar aerial system can the transmitted radiation be confined to a single beam: some of the energy is radiated in other directions and can, under certain circumstances give rise to false echoes (in a primary radar system) or false interrogations. Such false echoes or interrogations appear as incorrectly positioned indications on the radar display system and may confuse the operator. As will be seen, however, the problem in secondary radar can be solved in a rather more satisfactory manner if a separate interrogator is used than it can if the primary radar interrogates the transponder.

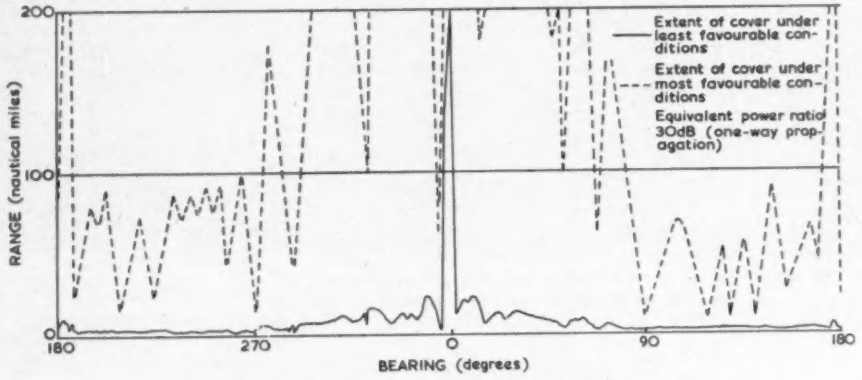

Fig. 1. Interrogation ranges for typical 1 000Mc/s directional aerial

For a practical u.h.f. aerial—that is, one whose horizontal aperture is restricted to manageable dimensions—the maximum gain in a direction other than that of the main forward lobe may be as great as one hundredth of that in the direction of the main lobe. From equation (2) it is evident that a remote receiver will receive from this sidelobe a signal of the same magnitude as it would receive from the main lobe if the distance between transmitter and receiver were ten times as great. Thus, in a u.h.f. secondary radar system, if the main lobe is capable of interrogating a transponder at a range of 200 nautical miles the principal sidelobe may be capable of interrogating it at 20 nautical miles.

This in itself is bad enough, but in a practical system certain other measures have to be taken which aggravate

the problem. To achieve reasonable reliability of detection, as already noted, it is necessary to make allowance for variations in the polar pattern of the airborne aerial: a reasonable allowance at u.h.f. is some 16dB. It is also necessary to allow for variations, from aircraft to aircraft, in the attenuation in the feeder from the aerial to the transponder (3dB); for run-down of transponder sensitivity under service conditions (3dB) and for run-down of interrogator transmitter power under service conditions (0 to 3dB depending on the arrangements for servicing.) Depending on the kind of interrogator aerial used, it may also be necessary, to ensure solid cover up to a particular aircraft altitude, to allow for variations in the interrogator radiation pattern in the vertical plane: a suitable allowance here might be as much as 20dB. The sum of these allowances will be somewhere in the range 20 to 45dB: assume here that it is 30dB. This means that a sidelobe of only one-thousandth of the power of the main lobe will be capable, under the most favourable conditions, of interrogating a transponder at the maximum designed system range, and that the sidelobe previously considered will

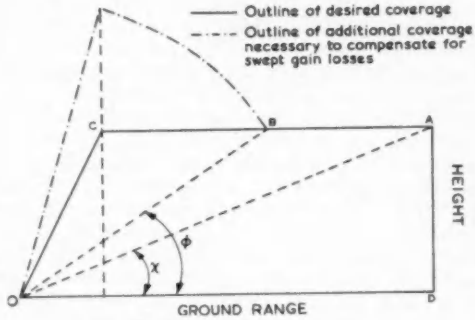

Fig. 2. Ideal coverage for a radar system

interrogate at maximum range under conditions which are some way from being the most favourable.

An impression of the seriousness of the problem can be gained from an inspection of Fig. 1. This is based on the polar diagram of a 1 000Mc/s aerial having an aperture of 30ft. On the assumption that the main lobe from this aerial will just interrogate a transponder at 200 nautical miles under the least favourable conditions, the solid line in the illustration shows the ranges at which the transponder will be interrogated, under the same conditions, in other directions. The broken line, on the other hand, shows the ranges at which interrogation will take place under the most favourable conditions, assuming that these are 30dB better than the least favourable conditions. Clearly, even assuming conditions substantially less favourable than those represented by the broken line in Fig. 1, the number of false interrogations will be unacceptably large: if several aircraft were under surveillance at one time it would be extremely difficult for a radar operator to decide where they were.

Use of Swept Gain

A similar problem arises in primary radar systems—it can be seen from equation (4) that in primary as in secondary radar the maximum detection range for a given target is proportional to the square root of the aerial gain—but here it is less troublesome. This is partly because at most primary radar frequencies it is easier to design an aerial with small sidelobe radiation than it is in the case just considered (though this advantage is largely offset by the wide variations with aspect of the amount of power which an aircraft reflects which are encountered at the higher frequencies), partly because no allowance has to be made for airborne feeder losses or sensitivity run-down and partly because a primary radar aerial can usually be so designed as to reduce the allowance which must be made to compensate for variations in the radiation pattern of the aerial in the virtual plane to something well below that suggested above. Nevertheless, echoes from sidelobes will be detected in some circumstances.

Suppose that the gain of the aerial in whichever direction the biggest sidelobe lies is G_s: then from equation (1) the signal power which will be received when this sidelobe illuminates a target will be S_s, where:

$$S_s = x \frac{P_s G_s^2 \sigma}{r^4} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

If, therefore, the radar receiver sensitivity is reduced at the shorter ranges so that the effective minimum detectable signal is always greater than S_s it is possible to ensure that no echoes from sidelobe illuminations are detected. If this effective minimum detectable signal is denoted by s_e the conditions may be expressed thus:

$$s_e > x \frac{P_s G_s^2 \sigma}{r^4}, s_e \geqslant s_a \quad \ldots\ldots\ldots\ldots (8)$$

where s_a is the absolute minimum detectable signal for the radar as before. This technique of sensitivity reduction is known as 'swept gain' or 'sensitivity/time control'.

The technique cannot be applied, however, without paying a penalty. In Fig. 2 is shown diagrammatically the sort of vertical coverage which the designer of a primary surveillance radar seeks to achieve: the intention is that all aircraft of not less than a certain echoing area shall be 'seen' when they are at ranges and heights within the limits defined by the solid line. The maximum range at which the target is to be detected is OA and one may say that at this angle of elevation the gain of the aerial in the direction of the main lobe is G_a. At other angles of elevation the gain required is smaller by a factor (r^2/r_{max}^2) where r in this case is the slant range from O to the solid line. A target having the minimum specified echoing area and located anywhere along AC or AD will, under the least favourable conditions, give rise to the minimum detectable signal, s_a, at O. If swept gain is applied to the radar, however, as a target moves from A along AC there may be found a point B beyond which the target will not be detected because the effective minimum detectable signal has been made greater than that to which it is giving rise. Evidently, from equation (7) and the inequalities (8) the position of B is defined by:

$$s_e = s_a = x \cdot \frac{P_s G_s^2 \sigma}{OB^4}$$

and since:

$$s_a = x \frac{P_s G_a^2 \sigma}{OA^4}$$

$$\frac{P_s G_s^2 \sigma}{OB^4} = \frac{P_s G_a^2 \sigma}{OA^4}$$

whence:

$$OB = OA \sqrt{(G_s/G_a)}$$

and, since $OB \sin \phi = OA \sin \chi$

$$\sin \phi = \sin \chi \sqrt{(G_a/G_s)} \quad \ldots\ldots\ldots\ldots (9$$

Equation (9), however, describes the relationship between ϕ and χ when the swept gain has been set up to suppress sidelobe echoes under the same conditions of transmission, reflection and reception as those for which the line AC has

been defined. In practice it would be necessary to set up the swept gain to suppress sidelobe echoes under the most favourable conditions for the production of such echoes whereas for guaranteed cover AC must be defined for the least favourable conditions. It is necessary, therefore, to introduce a factor k into equation (9)—thus:

$$\sin\phi = \sin\chi \sqrt{(G_s/kG_s)} \quad \ldots\ldots\ldots \quad (10)$$

where k is the ratio of the transmitted powers necessary to detect a target under the least and most favourable conditions. This ratio might typically be 100:1 and for a good primary radar aerial G_s/G_s might be 10 000. If χ were about 3°, then equation (10) would give a value for ϕ of about 30°. If this were sufficient, swept gain would be a possible way of eliminating sidelobe echoes without loss of cover. If a higher coverage angle were required, it would be necessary to extend the basic cover by the inclusion of the area outlined by the chain-dotted line in Fig. 2.

This representation of the principles of swept gain is somewhat crude, but it serves to illustrate the difficulty of dealing with secondary radar sidelobe interrogations in this way. By replacing G_s by G_r, equation (10) becomes applicable to the secondary radar case: the typical values for $\sqrt{(G_r/kG_s)}$ are, however, very different from those just considered for $\sqrt{(G_s/kG_s)}$. With great care it may be just possible to make this quantity unity; but it has to be remembered that the swept gain law itself must be the subject of variation between successive settings-up and that practical aerial design considerations will usually preclude the possibility of effecting the large increase in vertical cover which is necessary to restore that which has been taken away by the swept gain. If $\sqrt{(G_r/kG_s)}$ is less than unity, of course, and this is quite likely, no swept gain arrangement can totally eliminate the possibility of displaying responses to sidelobe interrogations.

Nevertheless, for some years now swept gain has been used with secondary radar systems and, although it does not completely eliminate sidelobe indications on the display, it has been successful in removing a large proportion of them. The aerials of the interrogator-responsors of these systems have, however, usually been designed for mounting on top of a primary radar aerial and have conseqnently been of small vertical aperture: there has thus been little chance of modifying the vertical coverage pattern to compensate for the depredations of swept gain and considerable loss of high cover has had to be accepted.

Amplitude Comparison Suppression Methods

A more elegant way of eliminating sidelobe indications was invented during the early work at T.R.E., realized in the Cossor development and is now embodied in the international system. The technique employed involves the use of two interrogator aerial arrays, one of which has a highly directional radiation pattern while the other is much less directional. The aerials are so arranged that, when they are appropriately fed, the ratio of power radiated from one to power radiated from the other is markedly different in the direction of the main lobe of the directional aerial from its value in all other directions: by designing the transponder in such a way that it can distinguish between these two kinds of relationship it is possible to ensure that it replies only to interrogations in the direction of the main lobe.

The directional aerial of such a system is customarily known as the 'interrogator' aerial, and the other is called the 'control' aerial. For the system to work the radiation from the control aerial must be in excess of that from the interrogator aerial in all directions other than that of the main interrogator lobe—the inverse relationship would require that the control aerial be more directional than the interrogator aerial—which is *ex hypothesi* as directional as it can be made—but the relationship required in the direction of the main lobe is not so evident. Clearly, an interrogation must consist of at least one transmission from each aerial: equally clearly, the transponder must be able to recognize (a) that it is receiving an interrogation and (b) that the interrogation is or is not by a main lobe. If the two transmissions were on different carrier frequencies, the transponder could be programmed to reply only when it received a transmission at the interrogator frequency and when there was no coincident or adjacent signal at the control frequency and of greater amplitude: in this case it could reply to a main lobe interrogation when only one of the two signals was received and it would thus be possible to keep the control transmission power down by radiating little or no energy in the direction of the main interrogator lobe.

Moding

The use of separate interrogator and control frequencies is, however, open to the objections that it complicates the airborne equipment and that if interrogator and control aerials of small vertical aperture are used it will be difficult to maintain the correct relationship between the two radiation patterns at all angles of elevation: the maxima and minima of the two vertical polar patterns will occur at slightly different angles. The alternative is to use the same carrier frequency for both transmissions and to separate them in time. This technique has the added advantage that if the interval between the two transmissions is made a critical factor in determining whether the transponder will recognize the interrogation or not it is possible to operate a selective interrogation process by varying the spacing between the transmissions: this process is known as 'moding' and both the current military i.f.f. system and the civil aviation system make provision for several interrogation modes.

Two-Pulse and Three-Pulse Techniques

One thus arrives at the point where an interrogation must consist of at least one transmission from each aerial, and where the transponder must receive two signals at the correct mode spacing in order to recognize the interrogation and must receive a signal from the interrogator transmitter in the correct relationship with that from the control transmitter if it is to reply. Whether it needs to *receive* a signal from both transmitters depends upon the technique of sidelobe suppression employed. That which employs the smallest number of transmissions which will satisfy this requirement is the 'two-pulse' technique, in which one pulse is radiated from each aerial and the interval between the two pulses is the mode interval. Clearly, for such a system to work, both pulses must be received by the transponder on those occasions when it has to reply: it is therefore necessary that as much energy should be radiated from the control aerial in the direction of the main lobe as is radiated from the interrogator aerial; and, since more energy must be radiated in all other directions, it is evident that the control transmitter must be substantially more powerful than the interrogator transmitter.

The next simplest technique is 'three-pulse' suppression. In this the interrogator aerial radiates two pulses, separated by the mode interval, and the control aerial radiates a third pulse intermediately and bearing a fixed time relationship, independent of the mode interval, to the first of these pulses. In this case the requirement that the transponder should recognize the interrogation is met by the

two interrogator pulses, so that the energy radiated by the control aerial in the direction of the main lobe may be as small as is convenient.

'Grey Region'

In the two-pulse case, therefore, the transponder must be programmed to reply only when two pulses of correct mode spacing are received and when that received from the control transmitter does not exceed in amplitude that received from the interrogator transmitter by more than a prescribed amount. This amount is ideally zero, but practical design limitations make it necessary to specify a permitted range of relative received power levels. The way in which this range is customarily specified is to say that the transponder *must* reply if the interrogator signal is greater than a level X with respect to the control signal and that it *must not* reply if it is less than a level Y, also with respect to the control signal. If the level is between X and Y the transponder may or may not reply: this zone is known as the 'grey region' and experience suggests that it needs to be about 9dB (received signal power) in extent.

In the three-pulse case, the transponder must be programmed to reply only when two pulses are received and when no third pulse of greater than a prescribed amplitude with respect to the first pulse is received at a prescribed time after the receipt of the first pulse. Here again it is necessary to include a grey region in the programme.

It is worth noting that the two programmes are not incompatible: a main lobe two-pulse interrogation satisfies the three-pulse criteria and vice-versa. It is thus possible (and recent events, as will be shown, have made it necessary) to design a transponder to work with both systems.

Capture

Implicit in the foregoing is the assumption that the amplitude comparison in the transponder is made only over the interval defined by the first and last transmissions of the interrogation group. Some earlier proposals involved using the control transmission to set a level over a longer interval—which has some advantages from an equipment designer's viewpoint—but this is objectionable because of the extent of the 'capture' effect which can result from it. By this is meant the denial of service to a remote interrogator by strong interrogations from a nearby station which set a signal level which cannot be surmounted by the signals from the remote station. Some degree of capture is an inevitable concomitant of all amplitude-comparison sidelobe suppression systems: the task of the system designer must be to reduce it to a minimum, and this is done by restricting to a minimum the extension in time of the level set by the control transmission.

Reply Path Suppression Systems

Several other systems of sidelobe suppression on the interrogation path have been proposed at various times[3] but the principles involved are sufficiently similar to those which have been described above to make further description unnecessary. It is necessary, however, to make some further comment on the possibility of effecting the suppression on the air-to-ground path.

The use of swept gain is, of course, a form of reply-path sidelobe suppression: there is, however, another technique, more akin to the systems described above, in which two receiving aerials are employed at the responsor. The two aerials have polar patterns similar to those described above and the directional one is used for the transmission of whatever interrogation signals may be appropriate. The reply from the transponder is received by both aerials and the received signals are separately amplified in such a way that if the transponder is in the direction of the main lobe of the directional aerial the signal from this aerial is the greater of the two, and if the transponder is in any other direction the signal from the 'control' aerial is the greater. The two sets of signals are then compared by a subtraction process and the positive residuum is taken to consist of signals from transponders in the direction of the main lobe.

This technique is extremely attractive as a means of adding a sidelobe suppression facility to an existing secondary system (e.g. existing military systems in which there is no sidelobe suppression other than swept gain) without having to modify transponders, and for this reason the claims of its proponents cannot lightly be discounted. It is, however, open to a number of serious objections. First, for a given transponder, the effective system range is reduced: this is because when the video outputs of the two receivers are subtracted the noise outputs are added so that a greater initial signal-to-noise ratio is required to produce a detectable signal. Secondly the technique affords no protection against false indications caused by reflected radiation: to take one example a transponder may be interrogated by a sidelobe some 10° away from the main lobe; its response, transmitted directly to the responsor, should be rejected by the responsor as a sidelobe response; a few microseconds later, however, a reflection of that response by a suitable reflecting object (e.g. a large building or a hill) might be received apparently from the direction of the main lobe and would therefore be accepted as a proper response and displayed as such in an incorrect position. The only way round this difficulty is to arrange for the responsor to be disabled, on receipt of a sidelobe response, for long enough to ensure that no reflections can be received from the direction of the main lobe. In conditions where many transponders are within range of the interrogator[4] such a provision would result in a severe reduction in the ability of the equipment to detect transponders.

A third disadvantage of the technique results from differences in the receptivity of the two aerials to signals compounded—as signals received by a ground station commonly are—of a direct path signal and numerous minor local reflected signals. The effect of this difference is to produce a difference in received pulse shape at the video outputs of the two receivers which, in turn, will frequently result in a small positive residuum from a sidelobe signal. Such residua can be eliminated from the display only by still further increasing the signal-to-noise ratio required to produce a detectable signal.

'Fruit'

The fourth disadvantage is in some ways the most objectionable: it is that it does nothing to prevent the transponder from replying to sidelobe interrogations. This has two disadvantages: first, such replies, even though rejected by the interrogator-responsor which caused them, may yet be received by other responsors within range and, being on a radio frequency common to all responses, be displayed as a form of interference known as 'fruit': secondly, to avoid overloading the transponder transmitter, it is necessary to limit the transponder reply capability by desensitizing its receiver when the rate of reply reaches a certain figure. The effect of such desensitization is another form of capture[5], since service is necessarily denied to more remote stations in favour of local stations. Clearly, a smaller number of stations within range of the transponder

can cause this desensitization if sidelobes are allowed to trigger the transponder than if they are not: there is on these grounds, therefore, a sound argument not only against reply-path suppression, but also against interrogation-path suppression.

Defruiting

Reply-path suppression provides a considerable measure of discrimination against fruit: simple geometrical considerations, however, show that it is not in this respect

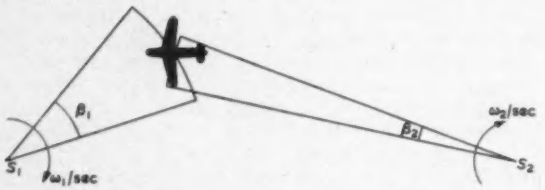

Fig. 3. Geometry of interrogation-path and reply-path sidelobe suppression systems

(a) If S_1 is an unsuppressed responsor and S_2 an interrogation-path suppression interrogator with recurrence frequency r, S_2 will cause the transponder to radiate responses at an average rate (assuming 100 per cent reply) of $r\beta_2/2\pi$ responses/sec

Of these S_1 will receive an average of $r\beta_1\beta_2/4\pi^2$ responses/sec as fruit

(b) If S_1 is an unsuppressed interrogator and S_2 a reply-path suppression responsor, the aircraft will radiate $r\beta_1/2\pi$ responses/sec, if the recurrence frequency is still r, and S_2 will receive $r\beta_1\beta_2/4\pi^2$ fruit pulses/sec on average The result is the same if the roles of S_1 and S_2 are reversed in each case: in a homogeneous system, therefore, the fruit problem is the same whichever type of suppression is used

superior to interrogation-path suppression (see Fig. 3). In a busy area, where several ground stations are interrogating numerous transponders, however, no technique of sidelobe suppression can alone sufficiently reduce the incidence of fruit to an acceptably low level: a special 'defruiting' technique is therefore necessary. In general, it is to be expected that the interrogation recurrence frequencies of the stations which are eliciting the interfering responses will be different from that of the station which is receiving them. If the responses from successive interrogations are compared, using a delay line one repetition period in length, therefore, and only those responses which appear in the same position in each train of signals are accepted, the majority of the interfering responses can be eliminated. Any residue of interference will be the result either of a coincidence in repetition rates between the local station and one of the interfering stations—which can only be dealt with if one station can be caused to change its repetition rate—or of chance coincidences of responses. The latter are unlikely to be troublesome if the general fruit level is kept down by the use of sidelobe suppression: if they should reach an unacceptable level they can be largely eliminated by a further stage of defruiting, but the practice of 'defruiting' is deprecated.

The important feature of defruiting is that two successive responses from the transponder are necessary to produce one acceptable response. To produce two such responses there must be either three successive responses from the transponder or two sets of two successive responses in a single illumination period. An operator using a visual display—and, however much is said about automatic air traffic control, the majority of control centres will be using visual displays for many years to come—is unlikely to recognize a single response unless it is preceded by 'paints', containing larger numbers of responses, from previous illuminations. He may notice a paint containing two responses, provided they are fairly close together, but from the point of view of the system designer it is necessary to contemplate the need for more responses per illumination period to ensure satisfactory system performance.

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(To be continued)

Development of Television Tape Recording

New developments of importance in the field of television tape recording were announced by Ampex Great Britain Ltd at a symposium and demonstration recently held at the firm's Reading headquarters.

The new units being shown for the first time in the U.K. were 'Colortec,' a direct colour television recording process; 'Amtec,' a time element compensator; 'Selective Editing,' a system for 'all-electronic' tape editing; the type 340 ferrite video head, a development which offers several times the operating life of the standard head and the VR-1002, a new, simplified version of Ampex's compact Videotape recorder.

Colortec is a small electronic chassis which will enable Ampex monochrome systems to be converted for colour recording and playback. The Colortec unit does not use the complex signal processing systems of encoding/decoding and heterodyning previously used in colour television recording. It uses instead a direct colour recording process which permits faithful recording and reproduction of colour input signals with full-bandwidth luminance and chrominance signals, and with sub-carrier interlace for improved reception of colour transmission on black and white receivers. The complete Colortec unit requires only 5¼in of vertical rack space, in contrast to the complete six-foot rack of electronic equipment previously required. The Colortec works in conjunction with Amtec and Intersync.

Amtec, which, by sampling timing accuracy once in each horizontal interval, accomplishes line-by-line compensation of timing errors in composite video signals, will eliminate geometric distortion of recorded television pictures such as skewing, quadrature and phase modulation. In addition to fulfilling this function, Amtec also provides a completely rigid lock of Videotape recorders equipped with Intersync to an external reference source. Intersync is a recent Ampex development which permits fades, mixes and other forms of special effects between the output of the Videotape recorder and other signal sources.

Of special interest to programme production personnel is Ampex's announcement of a fully-electronic editing device, called Selective Editing. This permits several types of editing without cutting and splicing of the tape and without vertical rolls or other picture degradation between programme elements. Selective Editing allows corrective inserts in previously recorded programmes; relatively elaborate productions with one camera and one Videotape recorder; and a number of animation effects which can be achieved through 'start-and-stop' recording.

Another new Ampex device is the model 340 ferrite video recording head, offered as an option in place of the standard Ampex head. Ampex state that the operating life of the ferrite head is 'several times' in excess of the average life of the standard alfenol head. The resonant frequency of the ferrite head is 8Mc/s (compared to 5·5Mc/s for the standard unit), the gap azimuth accuracy is plus or minus four minutes of arc, the quadrature error is reduced to plus or minus 5·5μsec horizontal displacement, and tracking accuracy has been improved to plus or minus 0·5 mils.

A Simple Electronic Chord Organ

By J. Venn*, B.Sc.

The concept of an electronic musical instrument designed to overcome some of the difficulties experienced by the beginner learning to play a musical instrument of the keyboard type is developed. A system involving the generation of four-note chords in any selected key at the touch of a single button is described and the extension of this system to a melodic keyboard is discussed. General details of a method of generating four-note chords with added 'sixths' or 'sevenths' in any selected major or minor key by the use of a set of 'tracked' oscillators are given, using this method, a simple instrument combining a three-octave, monophonic, keyboard-operated generator and a twelve-key, ten-chord, button-operated chord generator is described. Some details of the melodic and chord oscillators, octave dividers, keying stages, amplifiers, and power supplies are given. An experimental version of such an instrument has performed satisfactorily.

(Voir page 474 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 482)

FOR every one person, in this country, capable of playing a musical instrument competently, there are probably a hundred who would like to do so but who have either never tried to learn or who have abandoned their efforts at an early stage. The reason for this is believed to be that the time and effort required to achieve even a moderate ability in execution is excessive by present day standards. These people do not wish to emulate an Oistrakh, Solomon or Schweitzer, they only want, for their own satisfaction, to make their own music. The present popularity of the guitar, an instrument with which a comparative novice can make fairly pleasant noises after a short period of tuition, is an indication of this want. Unfortunately the piano, the most commonly available instrument, requires considerable manual dexterity and training; anyone wishing to play this instrument satisfactorily must be prepared to spend from two to four years in tuition and practice. There are certain 'short-cut' methods permitting one to 'vamp' accompaniments or to play specially arranged simple pieces at sight, but these have serious limitations. The pipe organ, on which many electronic musical instruments are based, is of course even more difficult to master. Thus electronic musical instruments have been, in the past, restricted to those with fairly considerable musical ability.

It has been the opinion of the author for some long time that by the use of modern electronic techniques, it should be possible to design an electronic musical instrument considerably easier to play than a piano or organ but capable of producing a satisfactory musical effect.

At this stage it is worth considering what is required of a simple solo musical instrument. If the instrument is monophonic, i.e. it can produce only one note at a time, it is generally unsatisfactory when played solo as the simple melodic line produced requires a harmonic accompaniment in order to sound interesting. Monophonic instruments such as woodwinds or brass are therefore usually played in groups or in accompaniment with a polyphonic instrument.

Although very simple and elegant electronic musical instruments of this type have been designed, e.g. the Solovox and Clavioline, they are almost always used with a piano to provide the required harmonies. A polyphonic instrument can produce more than one note at once, a 'double stopped' violin is a simple example, a pipe organ a very complex one; most keyboard instruments are of this type. It is obviously possible for such an instrument to provide both melody and harmonic accompaniment provided the executant has the required training and dexterity. Such instruments can be used to play more than one melodic line at once as well as harmonies.

It may be assumed, therefore, that the minimum requirement is the production of a melody, in any key, together with the production of accompanying chords suitable to the type of music and complementary to the melodic key. For example, a tune in the key of C major would generally require accompanying major or minor chords in the keys of F, C, G, A and D, roughly in that order of frequency of occurrence and with some chords requiring added 'sixths' or 'sevenths'. Thus, the common major chord in F consists of the notes F, A and C, that of C minor consists of C, E flat and G, with perhaps B flat as an added 'seventh' and so on. The major difficulty experienced by the novice in playing a keyboard instrument is the production of these accompanying chords, usually with the left hand, correctly and in time with the melody produced by the right hand. It is usually only a matter of a few weeks practice before the beginner can play 'one finger' tunes with his right in one or two keys and mastery of all twelve keys is more a matter of memory rather than dexterity.

A useful simplification is therefore to generate complete chords, each chord sounding on pressure of an appropriate button. This solution is, of course, used on the piano accordion and on the various electric accordions and electric and electronic chord organs produced to date. Each button selects the appropriate reeds or other tone sources for the chord required, e.g. 'C major + 6th' selects the tone sources for C, E, G and A. The pitch of the chord is, of course, determined by the pitch of its constituent tone sources, the more complicated instruments permit chord construction from sources in several octaves. However, though pressure of one button replaces pressure of several not obviously related keys, there are still quite a lot of buttons required, up to 120 in some piano-accordions; while even on the simpler electrically blown 'piano-organ' sixty buttons are required to produce five types of chord in the twelve keys. Simplification is further carried out on these instruments by the provision of masks to fit over the 'chord button' panels, these masks are suitably perforated to expose only those buttons likely to be required for the melodic key in use. This is somewhat inconvenient and does not overcome the difficulty that most commonly required chord buttons, e.g. F and C for a piece in C major, may be anywhere on the panel depending on the melodic key actually being used. It would be desirable that a certain button, identified as, say, '1.MA.' were always used for the chord equivalent to F

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major, '1.MI.' for F minor, '2.MA' for C major, etc. regardless of the key actually in use. If this could be done, only some five major and five minor chord buttons would be needed together with two or three more for adding sixths or sevenths or selecting octaves—a considerable reduction on the sixty or more used on the electric accordion or the ninety-eight used on a popular electronic chord organ. More important, the player would know that a given button always produced the same musical result, i.e. Button '2' would always produce a major or minor chord in the key of the melody. A twelve position 'key selector' to be discussed below would be used to change the chord keys appropriately.

As an extension of this principle, it is readily seen that if one can make a single chord button produce a chord in any desired key, the same is true for the note produced by any key on the keyboard. Another, lesser, source of difficulty to the beginner is the playing of melodies in various keys where he has to strike the appropriate black

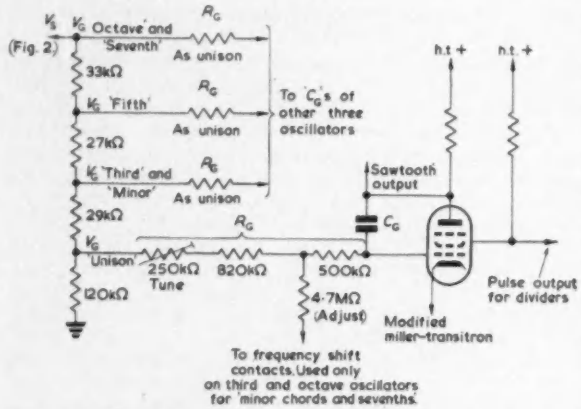


Fig. 1. System of tracked chord oscillators (one oscillator only is shown)
When key selector at 'C' and no buttons pressed, $V_s = +300V$ and: Unison 'C'
Third 'E'
Fifth G
Octave 'C'
Seventh B♭

keys as dictated by the key signature. By application of the 'key selector' principle to the keyboard, one can provide, on the 'melodic' part of the instrument a transposition facility so that a tune in any key could be played on the white keys only. For example, if the key of a piece of music were in, say, B flat, the key selector could be tuned to B flat and the music played as though it were in C, i.e. using only the white keys. The chord accompaniment is correct as the chord button key is changed at the same time. 'Accidentals', of course, would still require use of the black keys; this introduces some ambiguity in the correct identification of 'naturals', and in fact it would probably prove more convenient to play the melody in the conventional manner using black and white keys as required by the music. The facility would be useful, however, for transposition of melody to suit, say, the singing voice.

Realization

A simple instrument using the principles discussed above could consist therefore of a keyboard, the compass of which need not exceed three octaves, on which to play the melody; a 'chord-button' panel with some twelve to fourteen buttons for chord selection, insertion of 'sixths' or 'sevenths', generation of 'root-basses' (the fundamental or root note of the chord produced an octave or two lower) and pitch selection; a key selector and a 'transposition-switch' for transferring key selection to the keyboard if required. Assuming an electronic musical instrument, there would also be provided facilities for changing the timbre ('stops'), or pitch ('octave couplers') of the 'melodic' and 'chord' tone sources, some form of 'expression control', i.e. loudness and relative loudnesses of the two sources and probably some means of introducing vibrato to the melodic and/or chord sources. It should be noted that a non-electronic instrument can provide few or none of these latter facilities.

If electronic techniques are considered exclusively, it can be assumed that the tone-sources mentioned above are in fact some sort of oscillator. Given a group of these oscillators producing correctly related frequencies, then by mixing their outputs a chord is produced. For example, four oscillators may produce the notes C. E. G and C 8ve, i.e. the common chord of C major. If it were possible to change the 'C' oscillator to produce the note F and cause the other oscillators to 'track' so that they then produce the notes F, A, C, and F 8ve, the common chord of F major is produced. Injection of the seventh might be done by reducing the frequency of the C 8ve or F 8ve oscillator by a whole tone interval to produce B flat or E flat respectively. Thus for any four-note chord four oscillators are required, the frequency of which can be varied while maintaining exact frequency relationships; e.g. the relationships between C and G, an interval of a 'fifth' should always remain almost exactly two to three. The oscillators are better identified by their interval relationships as 'unison', corresponding to 'C'; 'minor or major third', E flat or E; 'fourth', F; 'Fifth or sixth', G or A; 'octave or minor seventh', C or B flat. The outputs of the 'unison' and 'fifth' oscillators can be fed to divide-by-two circuits to produce 'sub-octaves' and 'sub-fifths' an octave lower, these would then be used for the root-basses mentioned earlier.

The 'melodic' generator can consist of a similar oscillator, variable over three octaves, the tuning being determined by the keyboard; this provides a monophonic tone source and more divide-by-two circuits can be used to provide frequencies one and two octaves below the pitch of the 'melodic' oscillator.

General Principles and Details of Design

Although it is theoretically possible, given twelve single or six double tuned tone sources tuned to the notes of the chromatic scale, to produce any chord in any key and in fact to produce a 'chord-button' panel laid out to the principles discussed above, the switching required is complex. Any button must have access to four oscillators in twelve combinations. In fact, as shown above, only four oscillators are required, but they must be 'tracked' in constant relative frequency relationships. One solution to this problem, and it is certainly not the only one, is to use four Miller-transitron oscillators with identical anode-grid time-constants, the charging resistors being fed from tapped points of a voltage divider network. Assuming, at present, that the supply voltage to the network is constant, the oscillators will produce sawtooth waveforms of frequency determined primarily by the anode-grid time-constant R_gC_g and the voltage on the grid charging resistor V_g. (See Fig. 1).

If the oscillators are first trimmed by slight variations in R_gC_g and with equal V_g's to produce the same frequency, their relative frequencies are subsequently determined by their relative V_g's. It is therefore possible by selection of

the voltage divider to make all four oscillators work in chordal relationships and to maintain this relationship over some two octaves as the supply potential to the network V_s is altered by four to one, e.g. 50V to 200V. Thus five different voltages 'V_s' can be selected by five buttons to produce notes of, say, F, C, G, A and D from the 'unison' oscillator, the others maintaining their correct interval relationships to produce common chords with those notes as 'roots'. If the R_tC_t network in the 'thirds' oscillator can be modified so that its frequency is reduced by a semi-tone, the five buttons will then produce minor chords on the above notes. In practice, another five separate but identically contacting buttons are used with an additional contact for the frequency shift of the 'thirds' oscillator. Similarly a 'sevenths' shift bar can be used to lower the 'octave' oscillator a whole tone making it possible to produce major and minor chords 'plus seventh' but without the 'octave'.

Thus, ten alternative four-note chords are generated, the chords mentioned being in fact those used for music in the key of C major.

It is now required to produce the equivalent of these chords in the other eleven possible keys. (See Fig. 2.)

The supply voltage to the four-oscillator potential divider network V_s is generated from a variable resistor R_s, the variation being controlled by the five major and minor common contacts. R_s is supplied with current from a cathode-follower, the grid voltage of which is controlled over a range of two to one between 150 and 300V in twelve steps by a rotary switch, S_k. These voltage steps, generated from another twelve-point variable resistor, R_k, vary the frequency produced by the unison oscillator and hence the others in semi-tone steps, i.e. the key of the chord produced by each button is changed by this amount. Potentials are set such that with the selector in No. 1 position, the No. 2 chord button produces a chord in C, and the key selector is said to be in 'C'. Rotation to No. 2 position increases the resistance of R_k, hence V_s and No. 2 button now produces a chord in C sharp and the key selector is now in 'C sharp'. Similarly No. 1 chord goes from F to F sharp, and so with the other chords. Each step of the switch increases the frequencies by a semi-tone until at position 12, the No. 2 button now produces a chord in B, V_s having almost doubled in magnitude. It should be noted that the voltage change is carried out by resistance variation with a fixed current-limiting resistor rather than by changing the position of a potential divider tap. The reason for this is simply that the instrument can be tuned by building up these resistances incrementally; the addition of resistance to produce a higher voltage and thus a higher frequency does not change the lower values and therefore the tuning further down the resistance scale. A potential divider system would require a voltage source of zero impedance and a load of infinite impedance to be set up so simply. In practice the chord button and selector switch merely short-circuit to earth the appropriate sections of the resistance network, thus simplifying the contact arrangements and construction of the button and switch contacts.

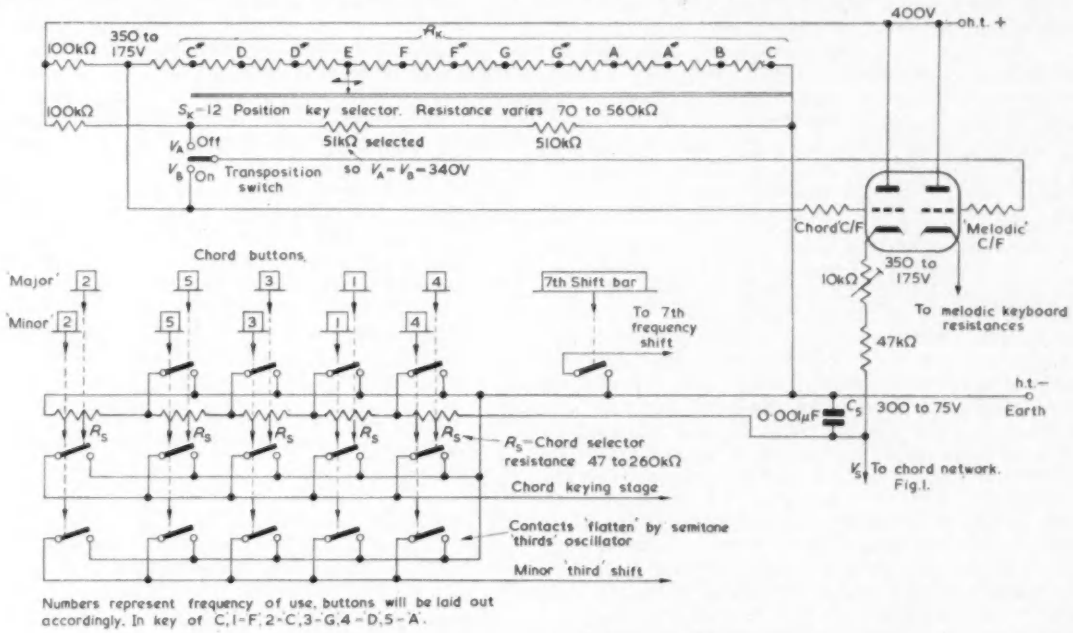

400V
h.t. +
100kΩ
350 to 175V
R_k
C C# D D# E F F# G G# A A# B C
100kΩ
S_k – 12 Position key selector. Resistance varies 70 to 560kΩ
51kΩ selected
510kΩ
V_A Off
V_B On Transposition switch
so $V_A = V_B = 340V$
Chord C/F
'Melodic' C/F
Chord buttons
'Major' 2 5 3 1 4
'Minor' 2 5 3 1 4
7th Shift bar
To 7th frequency shift
10kΩ
350 to 175V
To melodic keyboard resistances
47kΩ
h.t. – Earth
0·001μF
C_s
300 to 75V
R_s
R_s – Chord selector resistance 47 to 260kΩ
V_s To chord network. Fig.1.
Chord keying stage
Contacts 'flatten' by semitone 'thirds' oscillator
Minor 'third' shift
Numbers represent frequency of use, buttons will be laid out accordingly. In key of C, 1 = F, 2 = C, 3 = G, 4 = D, 5 = A.

Fig. 2. System of key and chord selection and tuning

This system is also used to tune the 'melodic' oscillator, another Miller-transitron tuned to operate over a range of three octaves, the lowest being one octave higher than the chord oscillators. A chain of thirty-six resistors is fed by a cathode-follower and the junction points of the chain are short-circuited to earth by contacts on the keyboard. The voltage produced is in the range 37·5V to 300V, the current through the network varying from 3·75mA through 10kΩ to 0·3mA through 1MΩ. The cathode-follower grid is fed either from a fixed voltage, this representing the normal condition, or from the 'key-selector' via the transposition switch. The fixed voltage is adjusted to be exactly twice that available at the first switch position, i.e. 'key of C' and the keyboard is tuned normally. On closing the transposition switch, the voltage supply to the keyboard resistors is controlled by the key selector and the pitch of the 'melodic keyboard' can be shifted in semi-

tone steps, through C sharp to B, i.e. from one octave below the normal pitch to one semi-tone below. Thus the pitch of the melody can be transposed by any desired amount within the octave, alternatively, for the novice, the device is used to reduce the key of the melody to 'C major'—in this case it should be remembered that the pitch of the melody is shifted down relative to the written music.

As an example, suppose it is desired to play a piece in the key of 'E'. This would normally require the use of four black keys, F sharp, C sharp, G sharp and D sharp. The key selector is, of course set to 'E' in order that the correct range of chords be provided. If the transposition switch be operated, the piece can now be played as though it were in 'C', no black keys being required, but the pitch of the melody has, however, been shifted down by an octave less a major third. For the sort of application for which this instrument is designed, this would probably not be objectionable—it would actually be more tolerable than the large number of wrong notes which usually result from the conventional approach.

It should be noted that as the melodic part of the instrument is monophonic and pressure of more than one key results only in production of the lowest note selected, a fruitful source of discords from mis-fingering has been eliminated.

As the output from the chord and melodic oscillators has a very accurate sawtooth waveform while the octave dividers produce true square waves, all the harmonics one might require are available for tone synthesis. The simple instrument discussed provides four 'stops' for each of the 'melodic' and 'chord' organs, four basic tone qualities, 'pipe', 'reed', 'horn' and 'string' being produced. Both 4ft and 8ft pitches are available separately or together to feed the 'melodic' stops; 8ft and 16ft together feed the 'chord' stops. A large range of tone colour is therefore available. A simple very-low-frequency phase-shift oscillator, switched by another 'stop', modulates the supply voltage to the keyboard resistors providing both frequency and amplitude modulated vibrato. The outputs of the 'chord' and 'melodic' stop units are controlled by a ganged, knee-operated potentiometer to provide expression control, a preset provides adjustment of relative volumes, the outputs are then mixed in a common amplifier.

The type of oscillator used is not very amenable to direct switching, keying is therefore carried out on the signal and as the 'melodic' and 'chord' organs require keying separately, double-triode push-pull keying stages are provided at the outputs of the 'stop' units and before the expression controls and mixer. These stages are controlled by common contacts on the chord buttons and keyboard respectively, a single earthing contact is all that is necessary. 'Attack' can be adjusted by a preset or varied by a 'stop' switch. 'Decay' or 'sustain' is not available as the frequency changes instantaneously to the 'top-note' value when any key or button is released, i.e. all resistance is in circuit. This change can be slowed sufficiently by a small storage capacitor C_s across V_s to permit the keying stage to switch off without undesirable bumps or squeaks but lengthy decay times are not permissible. The capacitor does not materially affect the frequency changes during rapid keying as the voltage changes are usually small. A slight 'swoop' is detectable if keys at opposite ends of the board are operated rapidly in succession. A chime or piano effect is available if the switching voltage be applied through a capacitor to the keying stage.

Any power amplifier can be used, but satisfactory results have been achieved with a small push-pull type using triode-connected 6BM8 triode-pentodes producing about 4W into an eight inch speaker. The instrument can therefore be assembled into a table cabinet approximately 36in by 15in by 8in. Fig. 3 shows a suitable layout.

The valve complement is as follows:

Melodic Oscillator	1 pentode
„ Divider	1 double triode
Chord Oscillators	4 pentodes
„ Dividers	2 double triodes
Vibrato Oscillator	1 pentode
Tuning network cathode follower	1 double triode
Keying stages	2 double triodes
Amplifier	2 triode pentodes
Total	14 valves + Rectifiers

The h.t. supply voltage is 340V at 90mA, dropped and decoupled at individual circuit units.

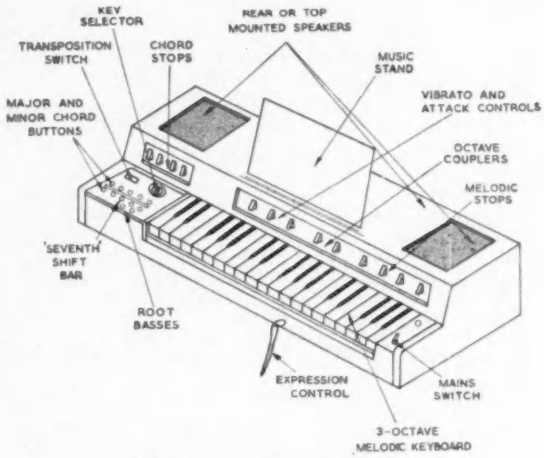


Fig. 3. Layout of basic instrument

Two particular points should be noted. Firstly in order to generate a voltage at the voltage-divider networks in the range 30 to 300V the cathode-follower cathode potential is of the order of 320V and the anode potential should exceed 400V. As the current required for both cathode-followers does not exceed 5mA this is best generated by a separate, indirectly-heated peak voltage rectifier and large electrolytic reservoir capacitor. Secondly, a separate heater-winding connected to a potential of about 150V should be used to supply this rectifier and the double-triode cathode-follower stage so that the maximum recommended heater-cathode potential differences are not exceeded.

Finally, it should be noted that stabilization of the h.t. supply is not required. The oscillators used are sensitive to both anode-potential and grid-charging potential variations; however, changes in these produce opposite effects on the oscillation frequency and the circuit has been designed so that these effects largely cancel; the grid-charging potential being derived from the same h.t. line as the anode supply, decoupling time-constants being equalized. No attempt should be made to stabilize the cathode-follower grid supplies without doing the same for the oscillator anode and screen supplies. In fact the h.t. supply can be varied over some 20V without affecting relative melodic-chord tuning and end-to-end tuning of the keyboard is only affected if the anode-cathode potential of

the cathode-follower is reduced below that required to maintain grid voltage/cathode voltage linearity. Absolute tuning is believed to be more than adequate for the purpose of the instrument.

A working 'mock-up' of an instrument has been made using a two-and-a-half octave electric accordion as the basis for the melodic keyboard and a rather crude fabrication of buttons and telephone relay springs for the chord-board. The effects realized are very pleasant, the tones produced being very representative of their classes, the transient characteristics are quite satisfactory and the chord blending is first class. Incidentally, it is possible to try the effect of 'justly' tuned chords based on 'equally tempered' scales. Further experience with the chord panel should produce an improved layout, it is difficult to determine at present whether the pedal accompaniment, available from the 'root bass' buttons, is better operated by the thumb or little finger of the left hand.

Conclusions

No attempt has been made by the author to give sufficient details to permit the instrument to be constructed by the reader. It is hoped that the design principles have been elucidated clearly enough for an electronic engineer to work out the constructional details for himself.

The Miller-transitrons have a number of unusual features, designed mainly to make them immune to stray pulse pick-up from other oscillators or dividers; any attempt by an oscillator to synchronize with another pulse train results in the production of rough and 'scratchy' tone as the wave-trains are no longer regular. It must be stressed that the overall purpose of the design is to produce a comparatively simple instrument which can, however, produce music satisfactory to the average person and which can be operated with a minimum of training and practice. Obviously, identification of the correct chord-buttons has to be learned, but it should be noted that sheet-music with chord-letter identification is readily available, being designed for the standard chord organ or electric accordion. All that is required for this instrument is a simple transposition chart so that the designated chords can be related to the button numbers 1 to 5, major or minor. In fact, the musical effect of each button is soon appreciated and 'home-made' harmonies can be added to any single line melody. It is almost impossible, unless the key-selector is set wrongly to produce very unpleasant noises! The chord numbers appropriate to the individual melodic line and the general atmosphere of the piece are quickly learnt.

Acknowledgments

The author is not aware that the Miller-transitron oscillator has been used before in any electronic musical instrument or that the technique of common voltage source control has been used for chord generation or key transposition. The rest of the circuits, in particular those of the divider and keying stages, are similar to those commonly used in the electronic organ field and described in many of the publications of Mr. Allan Douglas, to whom due acknowledgment is made.

Thanks are also due to Sir W. G. Armstrong Whitworth Aircraft Limited, Coventry, for assistance in the production of this article.

Solar Cells for Marine Buoy Lighting

The use of silicon solar cells for providing power for recharging batteries for marine buoy lighting is being investigated by the Corporation of Trinity House, the authority responsible for the maintenance of lighthouses, lightships and marine buoys around the coasts of England and Wales.

A number of experimental installations have now been built both at Trinity House and at its research centre at Dungeness, Kent.

In their research programme which is of necessity long-term in nature, Trinity House has already established practically that despite the unfavourable English climate, solar cell installations can provide the necessary power throughout the year to charge a small battery. However, because of the many problems still to be solved, it is not anticipated that the first fully equipped marine buoy installation can be available for operation before the end of 1963.

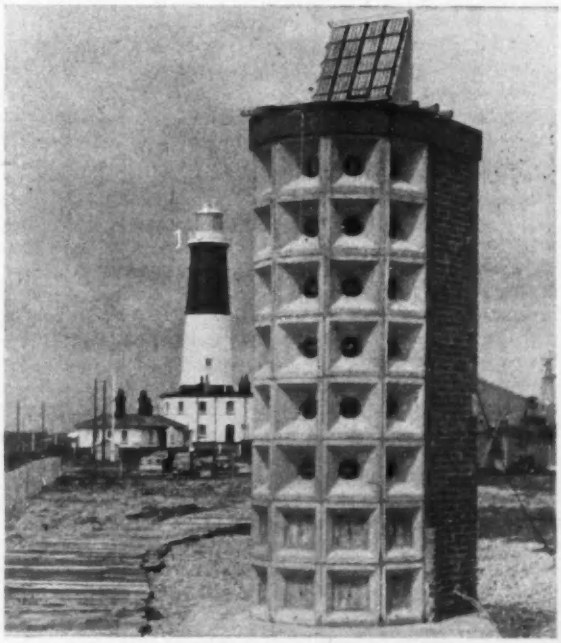
Experimental equipment which has already been built takes the form of a spherical glass bulkhead type fitting in which a block of four Ferranti MS11E silicon solar cells, wired in series, are mounted at an angle of inclination of latitude +15°. This ensures that a maximum charge is given to the 1·2V NIFE storage cell throughout the year. In peak sunlight conditions the maximum daily charge is of the order of 250mAh. Each cell provides about 0·4V on load.

A large experimental installation containing 400 solar cells, wired in series parallel has been made, the power derived from this bank being used to charge ten NIFE storage cells. This is intended for use on navigational lights situated in river estuaries, and it is hoped that investigations carried out on this installation will reveal whether it can be used successfully as the main source of power for operating a light without having to rely on a shore-based electrical installation.

The next stage will be the construction of a model buoy which will be tested in a static water tank to determine the physical configuration of solar cells mounted thereon, when the buoy is subjected to the effects of wind and heavy seas.

The NIFE storage cell which will be mounted in the well of the completed buoy, will be of the nickel-iron, alkaline type, with a capacity of 45Ah. It will not only provide the power to operate either a low-wattage electric filament lamp or Xenon flash tube during the hours of darkness, but will also operate a transistor coder to give the light the desired character for identification purposes.

A bank of 400 solar cells mounted on top of the experimental electrical fog warning apparatus at Dungeness



Silicon Four Layer Devices as High Power Pulse Generators

By R. P. F. Lauder*, B.Sc., A.M.I.E.E., A.M.Brit.I.R.E.

Several circuits are presented showing that pnpn devices in the two- or three-terminal configuration may be used as pulse generators delivering accurately rectangular power pulses for a variety of purposes including transmitters in the 20kW peak input power region.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

THERE is a wide range of semiconductor devices of the four-layer pnpn structure variously referred to as Shockley Diodes, pnpn transistors, thyristors etc., on the market. Details of their characteristics and performance as silicon controlled rectifiers in single and polyphase a.c. circuits have been widely reported. No attention, however, seems to have been paid to their potential use as narrow pulse generators, delivering considerable quantities of power and producing accurate pulses with good leading and trailing edges.

PNPN devices are made in both two-terminal and three-terminal configurations. The general voltage-current characteristic of both is the same and is shown in Fig. 1. The shape of this characteristic is accounted for by the fact that, of the three pn junctions in the device, two are forward biased and one is reverse biased. Up to a voltage V_{bo} (break-over voltage) only leakage current in the central reverse biased junction is passed and the device exhibits high impedance. At V_{bo}, the central junction avalanches, the voltage drop across the device falls to a low value (about 1V) and the structure exhibits low impedance with high current handling capabilities. The slope of the characteristic marked AB in Fig. 1 is of the order of $10^6\Omega$ in some devices, while the slope of CD is less than 10Ω; switching times from high to low impedance of the order of 50mμsec can be realized. The current marked I_h will be sustained and the device will remain in the low impedance state, currents less than I_h will permit the device to return to the high impedance state. It will be seen that pnpn devices exhibit all the characteristics of an excellent switch and are obvious candidates for pulse generation.

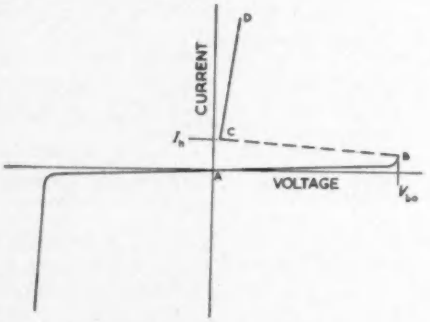


Fig. 1. Voltage/current characteristic of 4-layer devices

Two-Terminal Device Circuits

PNPN diodes are made with a range of V_{bo} from 20V to 200V and I_h from less than 200μA to roughly 50mA. Their dissipation is usually about 100mW. Fig. 2 shows a free-running pulse generator. (Fig. 2(a) giving a voltage spike output and Fig. 2(b) giving a rectangular pulse.)

The load resistors R_{L1} and R_{L2} are alternatives and one would not normally use both unless two outputs of opposite polarity were required. E_{bb} must be greater than V_{bo} to ensure that the circuit will be free running. On switching on, capacitor C charges through R_1 and the forward impedance of the diode MR_1 towards E_{bb}, when this exponential reaches V_{bo}, the pnpn avalanches and the capacitor discharges through it and the load resistor R_L with a current i in the direction shown in Fig. 2 and produces the output voltage V_o across R_L.

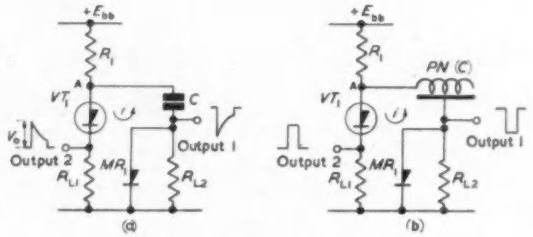


Fig. 2. Free running pulse generator

The time interval between output pulses is given by equation (1):

$$V_{bo} = E_{bb}\,[1 - \exp(-t/CR_1)] \quad \ldots\ldots\ldots \quad (1)$$

and the output voltage in Fig. 2(a) is described by equation (2):

$$V_o = V_{bo} \exp(-t/CR_L) \quad \ldots\ldots\ldots\ldots \quad (2)$$

Equation (2) is not quite accurate since V_o drops suddenly to zero when $i = V_{bo} \exp(-t/CR_L)/R_L$ reaches the value I_h when the device goes into the high impedance state. This will in general leave a small charge on C which will slightly modify equation (1) but this is usually so small as to be negligible.

It is advisable to make $t \simeq CR_1$ in equation (1) since these pnpn devices rarely have a selection tolerance in V_{bo} better than ± 5 per cent, and with this time-constant 5 per

* Ferranti Ltd., Edinburgh.

cent variation in V_{bo} has a smaller effect on the timing than, say, $t = 3CR$, since the waveform is rising through V_{bo} more quickly. Fig. 3 illustrates this effect.

If R_1 is made a preset resistor, clearly this problem does not arise. However, some manufacturers state that if the rate of rise of voltage across the device exceeds 10^6V/sec as it enters the V_{bo} region, then the value of V_{bo} will be modified. This modification is small and of the order of 1 or 2 per cent and rates of rise of at least an order of magnitude greater than this have been used with success.

The circuit of Fig. 2(a) produces a voltage spike of maximum amplitude equal to V_{bo} (since $V_o = V_{bo}$ at $t = 0$ in equation (2)) with an output impedance roughly equal to R_L. R_L is limited by equation (3):

$$i_{max} = V_o/R_L \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

For most two-terminal devices $i_{max} = 5$A, and if V_{bo} is 100V, then R_L must not be less than 20Ω. The duty ratio and dissipation limits must be taken into account along

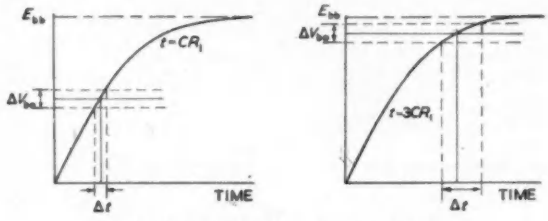


Fig. 3. The effect of V_{bo} tolerance on timing

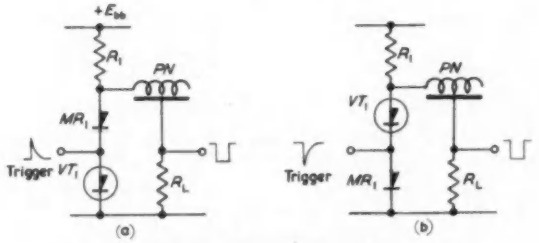


Fig. 4. Triggered circuits for either polarity of input

with considerations of voltage rate of rise mentioned above, and most devices derate linearly to zero at 125°C at a rate of 1mW/°C.

If a square pulse with a flat top and good edges is required then the capacitor may be replaced by a pulse forming network with the required parameters (see Fig. 2(b)). In this case $R_L = Z_o$, where Z_o is the characteristic impedance of the network.

$$Z_o = \sqrt{(L/C)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

and the pulse width t_p is given by:

$$t_p = 2CZ_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

The '2' in equation (5) showing that the pulse travels twice through the network, being reflected at the open end. It is sometimes worth while to make R_L slightly less than Z_o, which has the effect of making the anode of the pnpn device go slightly negative with respect to the cathode, thus ensuring its rapid return to the high impedance state. The output pulse voltage in this arrangement is, of course, $\frac{1}{2}V_{bo}$. This means that the output impedance is also halved. (E.g. in the case quoted above, $V_{bo} = 100$V, $i_{max} = 5$A, $V_o = 50$V, then R_L must be not less than 10Ω.)

The diode MR_1 in Fig. 2 is only required if it is necessary to prevent overshoot after the pulse. The amount of overshoot depends on the peak charging current and the value of $R_L + R_1$. 5A pulses with leading edges of 0·1μsec can readily be obtained from this circuit. In this case the rate of change of current in the load resistor is 5×10^7A/sec, and it will be obvious that wire-wound resistors should be avoided for this purpose since an inductance of, say 20μH will give rise to a voltage of 1kV under these conditions.

If E_{bb} is made less than V_{bo}, then the circuit will not free-run and may be triggered by an external pulse. Fig. 4 shows two possible arrangements.

The diode MR_1 must be capable of passing the peak discharge current. The minimum trigger voltage required is obviously:

$$V_t \geqslant V_{bo} - E_{bb} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

since in the high impedance state, all the supply voltage appears across VT_1.

Equation (6) may lead to inconveniently high trigger voltages if the supply voltage available is not compatible with V_{bo}. In this case a suitable Zener diode may be used as shown in Fig. 5.

Here E_{bb} may again be made larger than V_{bo}, and the Zener diode MRZ made slightly less than V_{bo} − 5 per cent.

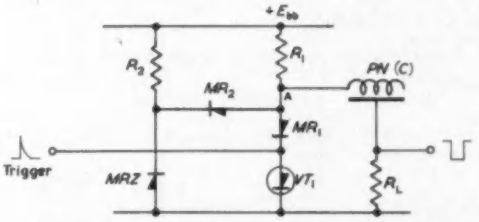


Fig. 5. Triggered circuits with supply voltage greater than V_{bo}

When the voltage at point A—which is rising exponentially towards E_{bb}—reaches V_z (the Zener voltage), the diode MR_2 conducts and holds point A at this voltage. R_1 should be made larger than R_2 so that the maximum permissible Zener current is not exceeded. This arrangement has a certain elegance in that it is relatively independent of temperature since the temperature coefficients of Zener voltage and V_{bo} in pnpn diodes are usually the same, namely +0·1 per cent/°C, the circuit thus tends to be self-compensating, and as V_{bo} rises with temperature, the Zener voltage rises by the same amount. Since:

$$V_t = V_{bo} - V_z \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

the trigger voltage required is a constant.

Circuits With Higher Output Powers

If higher output power is required, since i_{max} is a limit, the voltage must be increased. This may be done by stacking the diodes in series. Fig. 6 shows a practical circuit giving a 250V rectangular pulse 3μsec wide into 437Ω and may be triggered at 2kc/s. Such a pulse is suitable for driving the grid of a 5C22 type thyratron handling some 600kW peak power. The pnpn diodes used are Ferranti DSIG's with $V_{bo} = 100$V ±5V, $I_h = 10$ to 25mA. The pulse forming network contains 17 sections of 6·6μH + 1 000pF each in an L-section configuration, with 1·5μsec 'one-way' delay time and $Z_o = 90\Omega$. This impedance is matched to the 437Ω in the output by the pulse transformer T_1. The balancing resistors R_2, R_3, and R_4 are necessary to avoid unequal voltage distribution in the chain of pnpn devices due to variation in the 'off' impedances. With the

TABLE 1

Ratings and Characteristics of Several Devices

		TEXAS IS602	G.E.C. SCR965	WESTINGHOUSE CS31J	INTERNATIONAL RECTIFIER 10RC20	A.E.I. CR10.201A	G.E. C35B	TRANSITRON TCR2020
Absolute Max. Ratings								
Breakover Voltage	(V)	200	200	200	200	200	200	200
Transient P.I.V. (<5msec)	(V)	—	300	—	—	—	300	—
Average Forward Current	(A)	3	10	32	10	10	16	20
Recurrent Peak Current	(A)	10	—	350	—	50*	—	—
Peak One Cycle Surge Current	(A)	25	120	580	125	85	150	150
Peak Gate Power	(W)	—	5	2	5	5	5	10
Average Gate Power	(W)	—	0·5	0·5	0·5	1·0	0·5	1·0
Peak Gate Current	(A)	0·1	2	0·5	2	2	2	3
Peak Gate Voltage (Forward)	(V)	—	10	10	10	10	10	10
Peak Gate Voltage (Reverse)	(V)	−5	−5	−10	—	−5	−5	−10
Peak Gate Voltage (Anode Negative)	(V)	—	—	0·25	—	0·25	—	—
Max. Gate Impedance	(Ω)	—	—	250	—	—	—	—
Min. Gate Impedance	(Ω)	—	—	50	—	—	—	—
Characteristics (at Max. Ratings)								
Breakover Current	(mA) Typ.	2·5*	—	5	—	—	—	—
	(mA) Max.	—		20				
Instantaneous Forward and Reverse Leakage Current	(mA) Typ.	1	—	2	6	8*	—	—
	(mA) Max.	—	6	20	12	—	12*	3
Holding Current	(mA) Min.	0·1	—	—			—	—
	(mA) Typ.	5	20	5	—	—	10	25
	(mA) Max.	25	—	25			—	—
Peak Volts Drop at Peak Forward Current	(V) Typ.	—	—	1.6	—	2·1*	—	—
	(V) Max.	2·0	1·25	1.8	1·25	—	0·86	0·82
Gate Firing Current	(mA) Min.	—	—	—	—	50*	—	—
	(mA) Typ.	5	20	10	—	—	10	25
	(mA) Max.	20	85	50	85	130*	25	50
Gate Firing Voltage	(V) Min.		—	0.2	—	0·25*	0·25	—
	(V) Typ.	—	1·5	1.0	—	—	1·5	—
	(V) Max.		3·5	2.5	5	4·5*	3·0	3
Forward Gate Voltage Drop (I_a=0)	(V) Typ.	1·5	—	—	—	—	—	—
	(V) Max.	3·0						
Turn on Time	(μsec) Min.	0·35*	1·0	—		—	1·0	—
	(μsec) Typ.	0·45*	—	2·0	—	2·0*	—	2·0
	(μsec) Max.	0·70*	4·5	—		—	4·5	—
Turn Off Time	(μsec) Min.	3·5*	10	—		—	10	—
	(μsec) Typ.	4·5*	—	20	—	8*	—	7·0
	(μsec) Max.	7·0*	20	—		—	20	—
Thermal Resistance	(°C/W) Typ.	—	2.5	0.55	—	—	—	—
	(°C/W) Max.		—	—	2		2	
Max. Breakover Voltage Available	(V)	400	200	400	200	300	500	400

* *Indicates a figure taken from a graph.*

supply voltage shown, each diode holds off 83·3V. The trigger voltage is applied across the bottom diode and must be not less than 21·7V for a positive trigger. Once the bottom diode has been switched to the low impedance state, the supply voltage is divided equally between the remaining two, i.e. 125V each which is above V_{bo} + 5 per cent and therefore the whole chain avalanches. Alternatively, a negative trigger of not less than 44·4V may be applied to the same point to switch the two top diodes, when the bottom one will also avalanche for the same reason.

Care must be taken in selecting a value for C_1. Consider a positive trigger; when VT_3 avalanches, nearly all the trigger voltage appears across C_1, so that its left-hand plate

is positive. When the chain avalanches, C_1 must discharge via the input impedance (Z_{in}) of the circuit and the trigger circuit output impedance in series. In this case $Z_{in} \simeq 670k\Omega$ and $Z_t = 1k\Omega$, therefore C_1 $(Z_{in} + Z_t) = 67\mu sec$. This is a reasonable time-constant for a $500\mu sec$ period between pulses.

Three-Terminal Device Circuits

Turning now to the device commonly known as the silicon controlled rectifier, one has a component capable of handling considerable quantities of power and circuits offering greater flexibility due to the isolation between input and output. Manufacturers of these components usually claim that they are replacements for the thyratron valve, meaning the rectifier thyratron. It is argued that these devices also replace the switching thyratron used in pulse generator and pulse modulator circuits. The ratio of peak

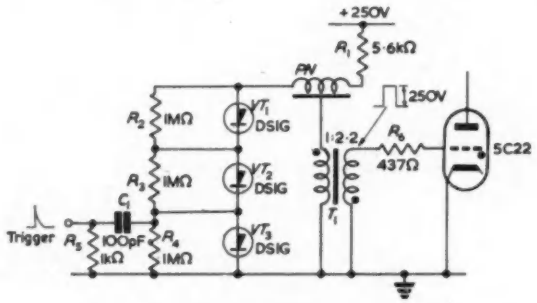


Fig. 6. Drive circuit for a 600kW peak power thyratron

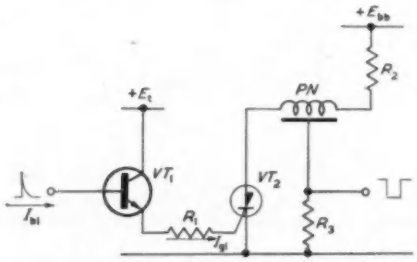


Fig. 7. Method of triggering a gated pnpn

output to peak input powers is commonly 10^6, i.e. 10mW peak input power to the gate will switch 10kW peak output power in the anode circuit. Moreover, if a pulse forming network is used in an arrangement similar to Fig. 2(b) then rectangular pulses with very good leading and trailing edges can be produced. Since the duty ratio in this application is typically not greater than 10^{-2}, one can take advantage of the very high surge rating of these devices.

Table 1 shows the characteristics of five silicon controlled rectifiers available in the U.K. and two available in the U.S.A. collated from the manufacturers' data sheets. (These sheets do not always contain the same amount of information, hence the blank spaces.)

This Table is by no means exhaustive and further information may be found in the individual data sheets. It will be noticed that the gate currents required are rather higher than those encountered in most trigger circuits, however, Fig. 7 shows a circuit which easily overcomes this difficulty.

Obviously in this circuit:

$$I_{g1} = \alpha' I_{bi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Assuming that VT_1 is bottomed, to a first approximation:

$$I_{g1} = \frac{E_t}{R_1 + R_g} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

where R_g is the gate impedance. Most of these components have a delay time between the start of I_g and the start of anode current flow of the order of $1\mu sec$ at the value of

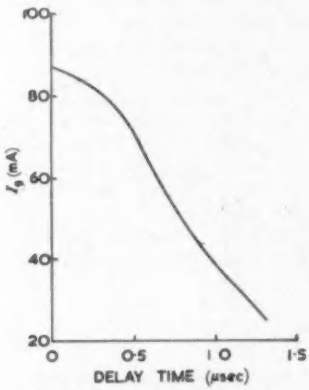


Fig. 8. Delay time as a function of gate current

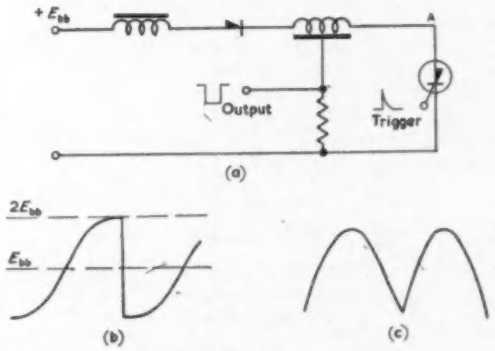


Fig. 9. Resonant charging circuit

minimum gate current. In addition, there is a further delay up to about $1{\cdot}5\mu sec$ or more as the gate current is reduced to the point where the unit refuses to fire. Fig. 8 shows a typical delay curve for this period. It must be emphasized, however, that this in no way affects the leading edge shape of the output pulse produced.

Care must be taken in selecting a value for R_2 (Fig. 7) when high repetition rates are required. The initial value of charging current to the pulse forming network (*PN*) is clearly $E_{bb}/(R_2 + R_3)$ and if this exceeds I_h there is a danger that the device will refuse to switch to the high impedance state. However, if as recommended above, R_3 is made slightly less than Z_o of the network, and the anode of the device is driven slightly negative, there is rarely any difficulty and it is the author's experience that E_{bb}/R_2 can be made considerably larger than I_h without this trouble being experienced, at least at low power levels. Another solution is to halve E_{bb} and use resonant charging with a choke and a hold-off diode if necessary. This has the advantage of very greatly slowing up the rate of rise of

voltage on the anode of the device and making the charging current sinusoidal instead of exponential. Fig. 9(a) shows this arrangement.

The diode in this circuit must, of course, pass the peak charging current in the choke and withstand a p.i.v. of $2E_{bb}$ approximately.

Full advantage of the very large pulse currents possible with these devices cannot be taken since, with, say, a device of 200V p.i.v., a 100V pulse is generated, and for

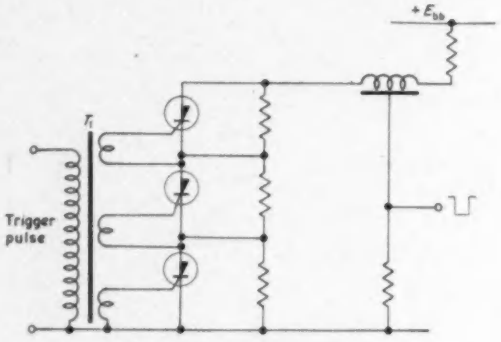


Fig. 10. Parallel gate drive circuit

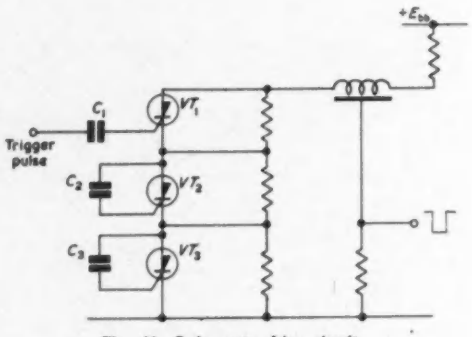


Fig. 11. Series gate drive circuit

maximum power, the load and hence the network impedance must be a few ohms, which is impractical with small pulse forming networks. If more peak output power is required therefore, one may resort to the technique of Fig. 6 and stack the devices in series to increase the p.i.v. In this case, either all the devices are triggered simultaneously as in Fig. 10, or the bottom pnpn of the chain only is triggered, and the increase in applied voltage across the others is used to fire them as though they were two-terminal devices.

The trigger circuit in Fig. 10 must supply considerable drive current, and the pulse transformer T_1 must have its secondary windings insulated from each other by the amount of the V_{bo} of each device. However, this circuit could possibly be made to produce pulses of the order of 1kV at considerable current. Using, say the Westinghouse 400V device CS31N, V_{bo} total is 1·2kV and E_{bb} could safely be made 1kV giving a 500V output pulse. Taking 50Ω as a minimum convenient value for the pulse forming network Z_o, then a 10A current pulse will be produced which is well within the capabilities of the device. That is a 5kW peak power pulse is provided. Turning to the trigger circuit, Table 1 shows that the minimum gate circuit impedance is 50Ω for each device, or 17Ω for the combined secondary impedance of T_1. However, Table 1 also shows that the maximum gate voltage required is 2·5V. If the circuit of Fig. 10 is driven with that of Fig. 2(b) using the Ferranti DSIG, a 50V output pulse is available. T_1 should have a step down ratio of 20:1, and the primary impedance of T_1 is, therefore, 17 × 400Ω or 6·8kΩ which is then the impedance of the drive circuit network. This is perhaps rather high and the turns ratio of T_1 can be reduced and some series resistance placed in the primary circuit to keep all the conditions right.

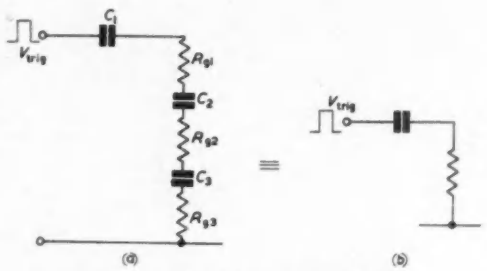


Fig. 12. Equivalent gate circuit for series drive

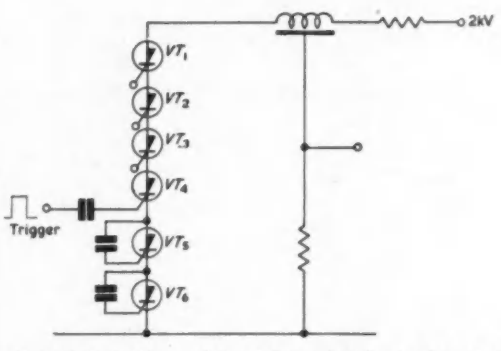


Fig. 13. Method of firing a chain of devices by triggering half of them

The foregoing shows that a trigger power of some 370mW will switch on an output pulse of 5kW, i.e. a ratio of 1·35 × 10^4.

An alternative circuit which avoids the use of the gate circuit transformer, is shown in Fig. 11.

This circuit envisages the gate-cathode circuits as being independent of the anode circuits and an equivalent gate circuit may be drawn as shown in Fig. 12.

Where R_g is the gate impedance of each device and C_o is the equivalent series capacitance of C_1, C_2 and C_3. It must be ensured that I_g is greater than the minimum gate current to fire any unit. Taking the Westinghouse device again, then $I_g \geqslant 50$mA. If a rectangular trigger pulse is applied, then from Fig. 12(b):

$$I_g = V_s \exp(-t/3C_oR_g)/3R_g \quad \ldots\ldots\ldots (10)$$

The turn-on time of the device must now be taken into account and it must be ensured that at the end of this period, I_g has not dropped below this value of 50mA. Equation (10) should therefore have the value of 50mA or more at $t = 2\mu$sec. Likewise, the peak gate voltage (10V) must not be exceeded. At $t = 0$ the applied trigger pulse

will be equally distributed among the three gates, therefore $V_t \leqslant 30V$. Taking $R_g = 50\Omega$, C_o can now be estimated from equation (10) and a value of 9 600pF is obtained. If all the capacitors are equal, each must be three times this value, say, 0·03μF. C_2 and C_3 must be rated for 400V and C_1 for 800V.

There is still some distance to go to produce a suitable pulse to drive even the smallest magnetrons. Postulating 4:1 as the largest reasonable turns ratio for an output pulse transformer, since most small magnetrons have a static impedance in the neighbourhood of 1kΩ, then the network impedance becomes about 60Ω. However, the output voltage required will be some 4 to 5kV in the secondary winding and 1 to 1·25kV in the primary, which in turn means 2 to 2·5kV peak network voltage. Therefore

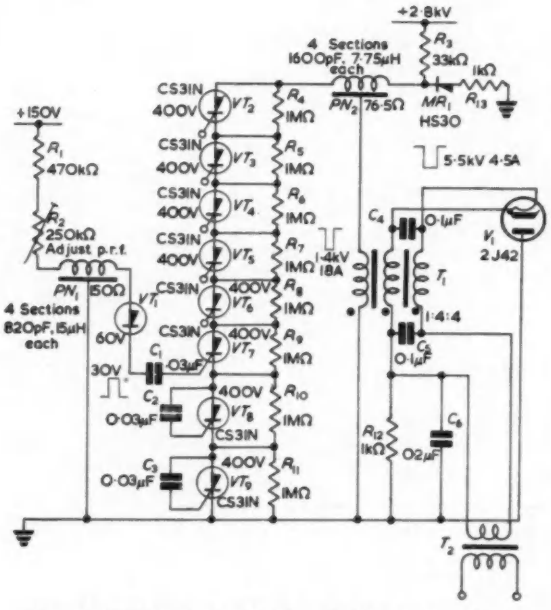


Fig. 14. Complete circuit of 7kW peak r.f. power transmitter

six or seven pnpn devices, of 400V V_{bo} each, must be used in series.

At first sight this would seem to complicate the trigger circuit considerably until it is remembered that although all the devices are three-terminal, they need not be used as such, and the circuit of Fig. 13 shows a possible solution.

This circuit resembles that of Fig. 6. Each device holds off some 370V and when the bottom three $VT_{4\text{-}6}$ are switched to low impedance, each of the top three has some 670V applied between anode and cathode and since this exceeds the rated V_{bo} by more than 50 per cent, the whole chain fires, and a 1kV primary pulse is produced.

Fig. 14 shows a complete circuit of a 7kW transmitter using a 2J42 type magnetron free-running at a p.r.f. of 1kp/s and using 1μsec pulse width: the only thermionic valve is the magnetron itself.

The diode MR_1 is used as a backswing diode to remove any reverse voltage left on PN_2 when the magnetron current ceases. Capacitors C_4 and C_5 ensure balance between the two halves of the bifilar secondary and avoid pulse currents flowing in the magnetron heater. C_6 and R_{12} form an integrating network across which may be monitored the mean magnetron current. The secondary of the heater transformer T_2 should have means, say a pair of relay contacts, for switching down the heater voltage when the e.h.t. is applied to avoid overheating the cathode. If a delay line is inserted between VT_1 cathode and C_1, then the input to the delay line will produce a useful prepulse for oscilloscope triggering etc.

Conclusions

PNPN devices can be used in a wide variety of pulse generator applications handling powers of at least an order of magnitude greater than transistors. It has been shown that small transmitters in the 7kW region may be pulsed by such devices directly and it is claimed that they are a direct replacement of the thyratron in this type of application.

It has been noticed that certain manufacturers have now put on the market silicon diodes with a single junction, capable of withstanding a 1·5kV p.i.v. and it is to be hoped that manufacturers will direct their efforts towards increasing the breakover voltage of four layer devices, thereby greatly increasing their usefulness. It would also be an advantage if magnetron manufacturers could make their product more compatible with the semiconductor age by attempting to reduce the static impedance, but it is realized that the penalty of greatly increased magnet size may have to be paid.

Acknowledgments

The author wishes to thank Mr. D. M. McCallum, Manager of the Electronic Systems Laboratory of Ferranti Ltd, Edinburgh, for his permission to publish this article, and Mr. J. Donaldson of these laboratories for his assistance in the experimental work. Acknowledgment is also made to the following for their permission to publish Table 1: Texas Instruments Ltd, The General Electric Co. Ltd, Westinghouse Brake & Signal Co. Ltd, International Rectifier Co. (Great Britain) Ltd, Associated Electrical Industries Ltd, General Electric Co, U.S.A., and Transitron Electronic Corporation.

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A Probability Distribution Analyser Utilizing Electrostatic Storage

By I. K. Harvey*

An instrument is described which, by electronic techniques, provides the one-dimensional probability distribution of any electrical variable.

Binary digital techniques are utilized and information accrued is stored in an electrostatic store of 960 digit capacity.

The amplitude range of interest is divided into 64 channels each of 15 digit capacity (32 767 counts per channel).

A linearity of ±0·25 per cent is achieved and input waveforms with frequencies extending from zero to an upper frequency limit of 20kc/s may be analysed.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

IN statistical studies useful information may be deduced from the one-dimensional probability distribution, which provides a measure of the relative time a stationary random variable spends at various amplitude levels.

An instrument[1] has been developed for the automatic determination of the probability distributions of samples from diverse electrical waveforms, or of any variable expressed in electrical form.

This instrument, or Probability Distribution Analyser, is fundamentally based on the Hutchinson and Scarrott pulse height analyser[2], but operates at a slower speed. Serial digital techniques are used, the output distribution being available either in binary or analogue form.

The working range of the waveform to be analysed is divided into a number of equal increments, or channels, each channel corresponding to a particular voltage. A repetitive pulse samples the signal to be analysed, and a count is fed into the channel corresponding to the signal voltage existing at the time of sampling. The channel selecting and counting operations are carried out in the interval between sampling pulses.

The voltage range of interest is divided into 64 increments or channels by a voltage-to-time conversion process. The signal voltage at the time of the sampling pulse is converted into a proportionally time delayed pulse (Fig. 2(d)). The time between sampling pulses is divided accurately into 64 equal intervals, each interval representing a channel. A count is then fed into the channel following that in which the delayed pulse occurs.

By using an analysing system of this type, effectively only one voltage discriminator is used, and relative channel drift is eliminated.

Each of the 64 channels in the time domain is further subdivided into 15 digit positions (Fig. 2(j)), in which positions the total number of counts for the particular channels are recorded in binary form. The maximum number of counts per channel is $2^{15} - 1$ or 32 767.

In order to retain previous information, a serial memory using an electrostatic storage tube of 960 binary digit capacity is used. Information held in this store is continuously displayed, during and following an analysis, on the screen of a monitor cathode-ray tube.

Binary numbers existing in the store are continuously read and rewritten in the time between sampling pulses. If a count is required to be registered in a particular channel an adding unit is triggered and the binary number existing in the channel advanced by 2°.

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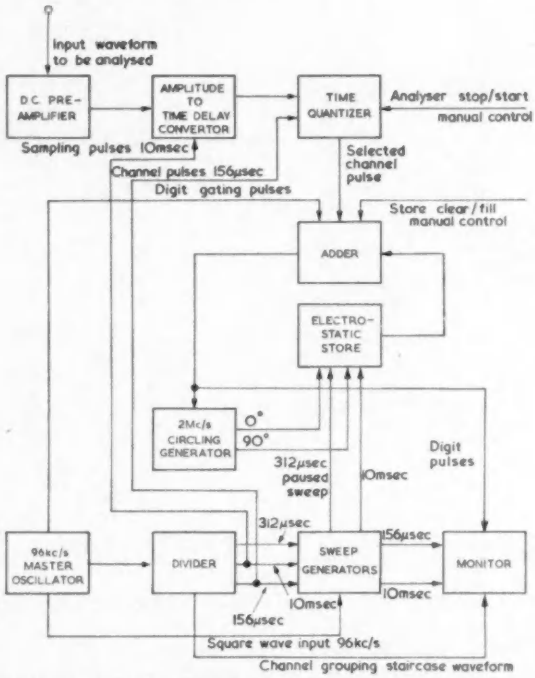

Fig. 1. Probability distribution analyser simplified block diagram

A more detailed description of the instrument with reference to the simplified block diagram (Fig. 1) follows.

Pre-amplifier

As the Probability Distribution Analyser has been designed to operate over a fixed 24V range of input voltage (0·375V channel width), a direct coupled pre-amplifier is used to extend the range of the instrument to lower voltage levels. Switched gains are provided, the maximum available gain being 25. Stabilization of the gain of this amplifier is achieved by negative feedback.

Amplitude to Time Delay Convertor

In this unit, a time delay proportional to the signal amplitude at the sampling time is generated by means of a bootstrap linear sweep generator in conjunction with a cathode coupled multivibrator comparator.

A direct coupled feedback amplifier is used to trans-

form the input voltage of ±12V to a range suitable for the operation of the following circuits.

A zero control, which injects an adjustable direct voltage into the amplifier, provides a means whereby the delayed pulse may be modulated over the full time range between sampling pulses for zero signal input to the amplifier. Within the range of this adjustment, the zero of a given distribution may be set to any desired channel.

A 2·5μsec signal sampling pulse at a 100c/s repetition rate is initiated by the final output pulse from the divider chain. This divider, in conjunction with a 96kc/s master oscillator, generates timing pulses for the synchronization of various internal waveform generators.

A pulse equal in amplitude to the instantaneous voltage of the signal at the sampling time is produced in this

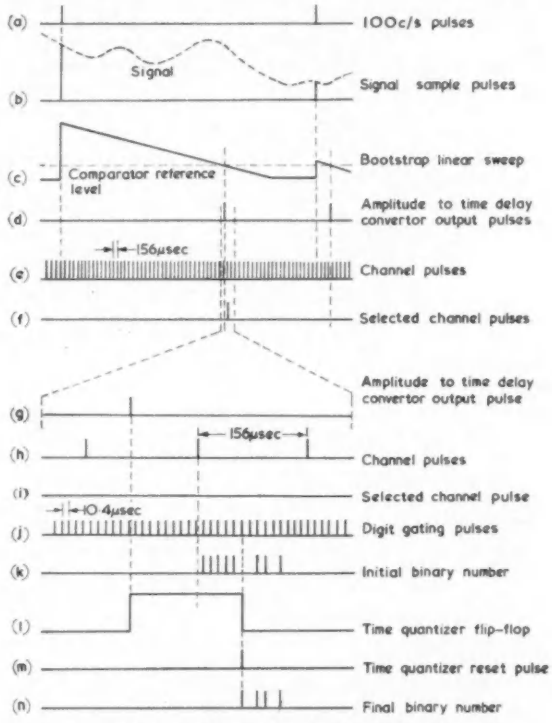

Fig. 2. Idealized waveforms of probability distribution analyser

unit (Fig. 2(b)). This pulse charges the timing capacitor of a bootstrap linear sweep generator. At the termination of the sampling pulse the sweep generator is isolated from the sampling circuit and the voltage on the sweep capacitor falls linearly (Fig. 2(c)).

When the linearly falling sweep voltage reaches a fixed reference level, a pulse is generated by the multivibrator comparator (Fig. 2(d), (g)). This pulse, whose position in time may be modulated over the entire time range between sampling pulses, is now fed to the time quantizer.

Time Quantizer

The time quantizer is required to select the first channel pulse following receipt of the delayed pulse from the amplitude to time delay convertor.

This unit comprises a gate controlling flip-flop which, when triggered, opens the gate to 6·4kc/s (156μsec period) channel frequency pulses (Fig. (2(e), (h)) from the divider. The first channel pulse passed by the gate (Fig. 2(f), (i)) is fed to the adder, from which unit, after completion of the addition process, a reset pulse (Fig. 2(m)) retriggers the time quantizer flip-flop to its initial condition.

The acquisition of samples by the analyser store is initiated and terminated by a manual control in the time

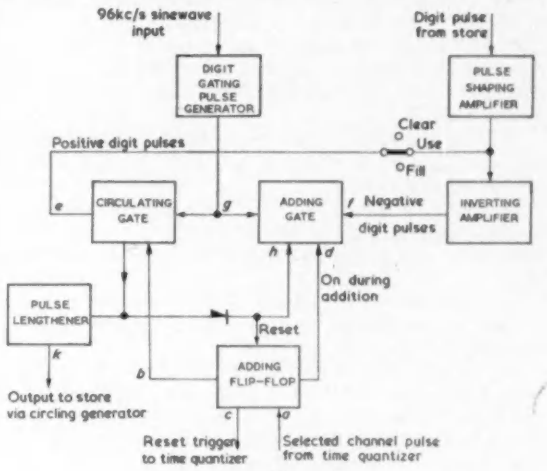

Fig. 3. Adding unit

Letters a, b, c, etc., refer to idealized waveform Fig. 4

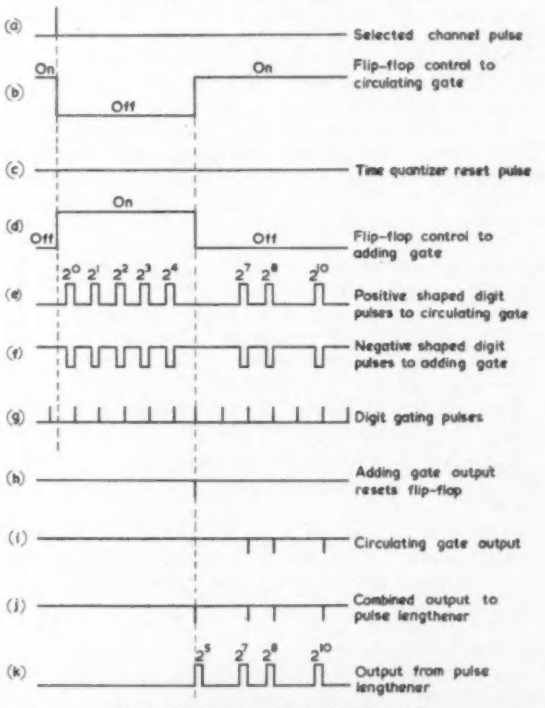

Fig. 4. Idealized waveform of adding unit

quantizer unit. This control inactivates the time quantizer flip-flop at all times save when sampling is desired.

The total number of samples taken by the analyser may be preset on an external counter unit. This unit automatically terminates the sampling function when the desired total is reached.

Adder

Digit pulses from the electrostatic store of the analyser are fed to the adding unit. In this unit these pulses are

gated, and, after reforming, are rewritten into the store.

A detailed block diagram of the adder is given in Fig. 3, the positions of occurrence of the idealized waveforms provided in Fig. 4 being indicated.

Digit pulses from the store, having a form as indicated in Fig. 5(g), are fed to a pulse shaping amplifier. This amplifier selects the positive going pulses resulting from the reading of digit positions in the store in which binary ones have previously been written. The portion selected is indicated in Fig. 5(g).

The approximately rectangular output of the pulse shaping amplifier is inverted, and each waveform is fed to one of two gates.

One of these gates, the circulating gate, is operative at all times save during the process of addition. The adding gate, as its name implies, is operative only during addition.

In these gates, the shaped digit pulses are gated by narrow pulses derived from the 96kc/s master oscillator and digit gating pulse generator.

The gated output is fed to a pulse lengthener producing wide digit pulses suitable for gating the circling generator.

Control of the process of addition is achieved by means of a flip-flop, which, on receiving a selected channel trigger from the time quantizer, renders operative the adding gate and inactivates the circulating gate.

Operation of the adder may be more clearly understood by reference to the idealized waveforms of Fig. 4.

Wavefom (a) represents the selected channel pulse, which, on triggering the adding flip-flop, produces waveforms (b) and (d), which are fed respectively to the circulating and adding gates.

The circulating gate, being rendered inoperative, no longer passes digit pulses. The adding gate is designed to produce an output only in the absence of a digit pulse.

Digits 2^0 to 2^4 inclusive are therefore rejected and a new digit is generated by the adding gate in the 2^5 digit position (Fig. 4(h)). This digit resets the adding flip-flop, bringing into operation the circulating gate, and inactivating the adding gate.

The 2^7, 2^8 and 2^{10} digits are then gated in normal fashion by the circulating gate, producing output waveform (i).

Waveforms (h) and (i) are combined, producing waveform (j), which is fed to the pulse lengthener.

The new binary number (k) may be seen to be an increase of 2^0 on the initial number (e).

A control is provided in the adding unit for clearing the store, or, for testing purposes, for completely filling the store.

Digit pulses from the pulse lengthener are fed to the circling generator, from which unit pulsed 2Mc/s sinusoids for application to the storage tube deflexion plates are derived.

Electrostatic Store

The analyser memory comprises an electrostatic store[5] in which the binary information is stored in the form of electrostatic charges on the face of a cathode-ray tube. Memory is extended to as long a period as desired by means of a regenerative process whereby the stored information is cyclically read and rewritten.

The storage tube comprises a conventional cathode-ray tube type 5CP1 to the face of which is attached a semi-transparent metallic mesh. This mesh serves as a capacitive pick-up plate upon which the changing charge distributions impressed upon the storage tube face by the electron beam induce corresponding voltages.

The form of these voltages after amplification, shaping, and gating, determines whether or not information is to be rewritten in the store.

Visual observation of the storage tube raster is permitted by use of a transparent mesh, and greatly facilitates the achievement of correct operating conditions.

A raster of 30 × 32 digit positions is formed on the face of the storage tube by applying appropriate sweep voltages to the respective electrostatic deflexion plates. The two sweep voltages required are a 10msec period linear sweep, and a paused sweep of 312μsec period.

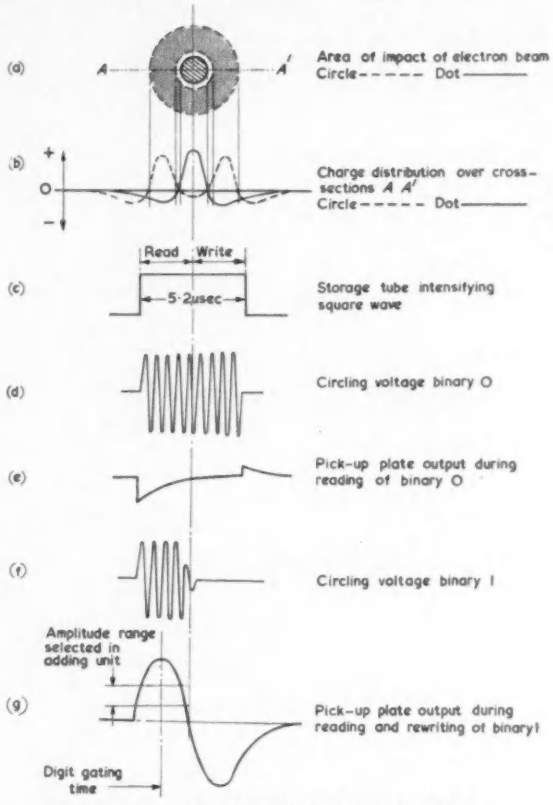

Fig. 5. Storage tube charge distributions and waveforms

The paused sweep is designed to hold the storage tube electron beam fixed in position during the read-write operation at each digit position. In the period between successive digit positions the storage tube is blanked. This blanking, and the stabilizing of the spot position during the read-write cycle, greatly minimizes spurious effects resulting from imperfections in the storage tube screen.

The linear 10msec period sweep required for the production of the storage tube raster is initiated by the 100c/s output pulses of the frequency divider. During the flyback of the 10msec sweep, a period of approximately 20μsec, the storage tube is blanked to prevent destruction of stored information. Deflexion defocusing effects are minimized by the application of paraphase sweep voltages to the storage tube deflexion plates.

The raster so formed represents 32 lines each containing 30 digit positions, and covers an area on the storage tube face of approximately 7·5cm square. However, due to the flyback time requirements of the 0·01sec sweep generator, two digit positions have been sacrificed, leaving a total number of possible binary digit positions of 958.

In actual use only 945 digits are used as the loss of the

above two digits results in the initial channel of 15 digits being rendered inoperative. The remaining 13 digits of the first channel could be made usable by the utilization of a simple gating circuit with appropriate delays but with attendant complication of the monitor circuits.

A circle dot storage system has been adopted in this equipment[4]. In this system the electron beam is sharply focused; circling being achieved by applying suitably phased, pulsed high frequency sinusoidal voltages to the deflecting plates of the storage tube. A circle diameter of approximately 1mm was found to be optimum.

Each digit position is initially read with the circle pattern (Fig. 5(d)). If a binary one is to be written, the sinusoid is prematurely clamped to zero to form a dot (Fig. 5(f)).

By utilizing a pulsed sinusoid whose envelope is slightly rising, a greater difference at the digit gating time between a binary one and zero is achieved.

In Figs. 5(a) and (b) are represented the charge distributions on the storage tube screen for both the circle and the dot patterns.

As the secondary emission coefficient of the storage tube screen is greater than one for the accelerating potential of 1·7kV used, the area of impingement of the primary electron beam acquires a positive charge. This charge builds up until a steady state potential is achieved, in which as many electrons are reattracted as escape to surrounding parts of the storage tube.

The area in the immediate vicinity of the beam acquires a negative charge due to the capture of secondary electrons, as shown in Fig. 5(b).

If a new pattern is superimposed upon the existing one, the previous charge distribution is swiftly destroyed, the rate of destruction being a function of the electron beam intensity, and the capacitance of the spot to the surrounding environment.

The intensity of the electron beam is so chosen as to result in erasure of the previous pattern in a time of approximately 2μsec. However, the intensity must not be excessive, as adjacent digit positions will be adversely affected by the secondary electrons emitted during operation on a particular digit position.

The change from one charge distribution to another requires the flow of current either to or from the storage surface. In the case of a circle being superimposed on a dot, a net positive charge has to be transferred to the storage surface, resulting in a positive voltage pulse being induced upon the pick-up plate (Fig. 5(g)). A negative pulse is derived from the pick-up plate during destruction of the circle by the dot pattern (Fig. 5(g)).

As a consequence of the rising envelope of the circling voltage, the reading of a previously written circle is equivalent to reading a large circle with a smaller circle, and results in an initial negative voltage pulse being induced on the pick-up plate. This negative pulse is shown in (Fig. 5(e)).

The positive pulse occurring at the termination of the digit read-write period is the result of interruption of the storage tube electron beam at the commencement of the inter-digit blanking period. A similar small negative pulse is produced at the initiation of the read-write period.

Focus of the storage tube is required to be uniformly sharp over the whole face of the tube, and some selection of tubes is required to obtain optimum operation.

Voltages induced on the pick-up plate at a level of 50mV peak are amplified, initially by a negative capacitance amplifier with a gain of 3·5, and finally by a two-stage, gain-controlled amplifier, before being fed to the adding unit at a level of 35V peak. The negative capacitance amplifier[5] is a feedback amplifier designed to cancel the major portion of the pick-up plate capacitance to ground. Cancellation of this capacitance permits an increase in the pick-up plate load resistance with correspondingly higher output voltages and lower required gain in the amplifiers.

Circling Generator

The generation of the circling voltages for the electrostatic store is achieved by means of a 2Mc/s gated oscillator. In the absence of binary digits, the oscillator is gated by a 96kc/s square wave derived from the master oscillator and produces pulsed sinusoids of 5·2μsec duration (Fig. 5(d)). If a digit pulse is present at the adder output, the gated oscillator is terminated after 2·5μsec, rewriting a digit in the particular store position (Fig. 5(f)).

To produce the circle pattern, pulsed sinusoidal voltages 90° apart in phase are added to the respective storage tube deflexion waveforms by means of coupling transformers; the phase shift being obtained by means of a distributed constant delay line having a delay time of 0·125μsec.

Sweep Generators

The paraphase 10msec linear and 312μsec paused sweep for storage tube deflexion, are generated by means of Miller integrators.

The 10msec sweep operates conventionally, and utilizes a cathode-follower to ensure rapid recharge of the timing capacitor at the end of each cycle. This sweep is reset by the 10msec period pulses of the divider chain.

Generation of the 312μsec paused sweep is achieved by integrating a large amplitude zero-based 96kc/s square wave by means of a Miller integrator which is periodically reset by 312μsec period pulses from the divider. The resulting output voltage from the integrator is held constant (paused) during alternate 5·2μsec intervals and runs down linearly in the intervening time between pauses.

Monitor cathode-ray tube Y sweep is derived from a bootstrap linear sweep generator reset by 156μsec period divider pulses. The 10msec linear sweep provides the X sweep for the monitor cathode-ray tube.

Monitor

A monitor oscillograph providing a visual display of information existing in the store is included in the Probability Distribution Analyser.

Two types of display may be selected, the first, shown in Fig. 6(a), provides a display of the total binary content of the store and is used when exact numerical results are required. The second display, shown in Fig. 6(b), is a decoded version of the above, and provides an approximate linear representation.

The display in binary form presents the 64 channels in the X direction, and, in the Y direction, the binary digits in increasing powers of two up to 2^{14}.

To facilitate the reading of this display, the channels are divided into 8 groups of 8 channels by means of a staircase waveform derived from the divider unit. This waveform is subtracted from the 10msec period sweep voltage fed to the monitor X amplifier.

All digit positions are indicated on the monitor cathode-ray tube using intensity modulation. Positions in which digits occur are portrayed as bright dots; fainter dots indicate the remaining digit positions.

The linear display (Fig. 6(b)) is obtained by decoding the binary content of each channel. In this system, attributed to Shannon by Meacham and Peterson[6], each digit of a serial binary number adds a fixed increment of charge to a capacitor. The capacitor is discharged exponentially,

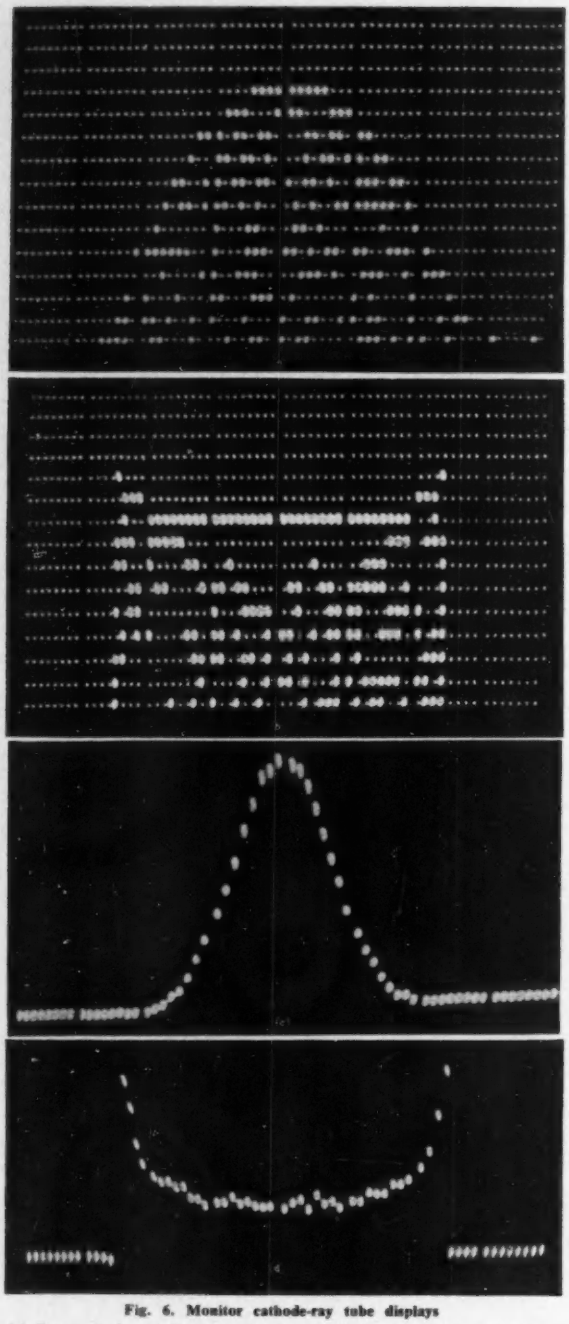

Fig. 6. Monitor cathode-ray tube displays

(a) Binary display of Gaussian distribution; (b) binary display of sine-wave distribution; (c) linear display of Gaussian distribution; (d) linear display of sine-wave distribution

its voltage decaying to half value in the digit period. The capacitor voltage is sampled following the final digit, this sample providing the analogue representation of the particular binary number.

In practice, the waveform on the capacitor is applied directly to the Y plates of the monitor tube, and the sampling done by means of an intensifying pulse.

The complete distribution is then portrayed as a series of dots, each dot representing a channel, its displacement from a reference level being proportional to the number of counts existing in that channel.

The intensifying pulse is derived from a variable delayed pulse generator, which provides a delay from the commencement of a channel quantized in multiples of the digit gating pulse period. In use, the delay of this pulse is adjusted manually to occur after the last binary digit in the channel containing the highest count.

Master Oscillator

The master oscillator is a Colpitts oscillator operating at a frequency of 96kc/s. From the 96kc/s sine wave of the master oscillator are derived digit gating pulses and a 96kc/s square wave for storage tube blanking and the gating of the circling generator. The 96kc/s square wave is also used to generate the pause in the 312μsec period paused sweep generator.

Divider Chain

Pulses derived from the master oscillator drive a divider chain producing pulses of 312μsec and 10msec period for synchronization of storage tube sweeps.

Pulses of 156μsec period for use as channel pulses and for the synchronization of the monitor Y sweep are derived from a subsidiary ÷ 3 divider stage operating from 52μsec period pulses of the main divider chain. By alteration of the division ratio of this subsidiary divider, the analyser may be made to operate with the following numbers of channels with corresponding digit content.

Division Ratio of Divider	*Number of Channels*	*Digits/ Channel*
6	32	30
4	48	20
3	64	15
2	96	10
1	192	5

Performance

The d.c. stability and linearity of the Probability Distribution Analyser depend upon the input pre-amplifier and the amplitude to time delay convertor.

After a warm up period of 15min the analyser is, for most requirements, essentially stable, the drift rate being approximately 0·04 channel per minute when operating at 64 channel capacity. A reduction in drift rate by a factor of approximately 10 is observed after a further 15min period.

Analyser linearity has been found to be ±0·25 per cent with improved accuracy towards the centre of the working range.

Signal frequencies extending from zero to an upper limit of approximately 20kc/s may be analysed without appreciable error. The upper frequency limit is occasioned by the finite sampling pulse width of 2·5μsec used in the analyser.

Acknowledgments

The author is indebted to Dr. D. G. Lampard formerly of the Division of Electrotechnology, C.S.I.R.O., who instigated this project and under whose general direction the work was carried out.

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A Low Drift D.C. Amplifier

By D. J. Collins*, B.Sc. (Eng.), A.M.I.E.E.

There is a natural trend of striving for increased accuracy of plant instrumentation. One of the factors influencing overall accuracy in low level d.c. systems is the performance of the amplifier. The requirement for an amplifier suitable for accuracies of 0·1 per cent of full scale has led to the development of the amplifier described in this article. The choice of configuration, the circuit arrangement, and the performance parameters are mentioned. Equivalent input drift of less than 2μV has been achieved in this commercially available unit.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

THE maximum sensitivity of simple directly-coupled amplifiers using hard valves as active elements has been found to be limited by the magnitude of the drift of the contact potential of the input stage. This drift which resolves itself in the form of an equivalent grid-cathode signal is of the order of 100mV peak in the simplest form of amplifier. Attempts at cancellation or compensation of this spurious input signal have improved the situation but, due to its random nature, have rarely achieved a long term figure of better than 10mV peak[1], and such amplifiers would not be suitable for use in instrumentation systems with transducers producing full scale outputs of the order of only 10mV.

One of the earliest solutions to the problem of obtaining high sensitivity d.c. gain is the use of the modulated amplifier. The transducer output is used to modulate a carrier wave which is then amplified by an a.c. amplifier and demodulated at a high level. The most common form is probably the simple chopper amplifier which uses an electromechanical relay to chop the transducer signal into a square wave form which is amplified and then demodulated, usually by a second contact on the relay.

Modulated amplifiers and carrier (or a.c.) systems suffer from two main disadvantages:—

(a) The dynamic bandwith of the system is limited to about 10 per cent of carrier frequency. Amplifiers using relays as modulators have operated at carrier frequencies as high as 1kc/s, but at such frequencies the life of the relay or chopper is short.

(b) In systems where the transducer acts as the modulator and is situated at some distance from the amplifier and demodulator (Fig. 1), there are invariably problems associated with the attenuation and phase shift of the transmission cables. In general, the higher the carrier frequency, the greater the magnitude of these problems.

While d.c. amplifiers of adequate sensitivity and bandwidth were not available, a.c. instrumentation systems were much used, but in recent years d.c. amplifiers of reasonable performance have been developed and there is an increasing tendency to return to the simpler d.c. systems. This is particularly true in the U.S.A., where today the vast majority of systems dealing with dynamic information involving many physical parameters are d.c. systems.

* *Solartron Research and Development Ltd.*

Amplifier Limitations

Accuracy and stability of gain, normal requirements of any instrumentation amplifier, are usually obtained by the use of overall negative feedback. If overall feedback is to be applied to a simple chopper amplifier, a demodulator filter will be required to reduce the residual carrier ripple, and this filter then limits the bandwidth of the amplifier. It is also difficult to obtain a large forward gain and worthwhile feedback in a system which involves a complex filter. For these reasons, the simple chopper amplifier has only limited use as a general purpose device. It can, however, be used as an auxiliary amplifier to provide drift correction for a d.c. amplifier of better bandwith performance. This configuration (Fig. 2), mentioned by Goldberg[2] has been used for amplifiers in analogue computers for a number of years.

The basic amplifier is directly coupled and, together with the auxiliary amplifier which gives drift correction, provides a basic d.c. open loop gain which is the product of the two individual gains. The gain of the system at, say, 1kc/s is purely that of the basic amplifier, and there is thus a large gain variation over the frequency range. Since the basic amplifier is directly coupled, the grid current of the first valve can also produce a spurious drift signal. This type of amplifier, although a tremendous improvement over the simple chopper amplifier, has still an equivalent input drift of the order of 100μV and probably only 80dB of open loop gain at 1kc/s. Its performance is not adequate for a high accuracy instrumentation system.

The Parallel Hybrid Amplifier

An alternative approach is that of the parallel hybrid amplifier, and an example of this has been described by Buckerfield[3].

Although the amplifier described by Buckerfield has only modest performance, the technique is suitable for development. Basically, the approach is to broaden the frequency response of a chopper amplifier by the parallel addition of a conventional a.c. amplifier having complementary frequency response. Buckerfield termed his con-

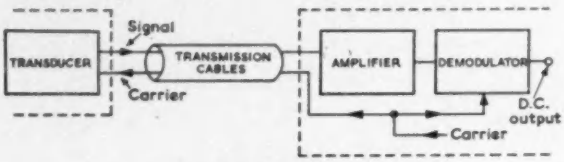

Fig. 1. Carrier type system

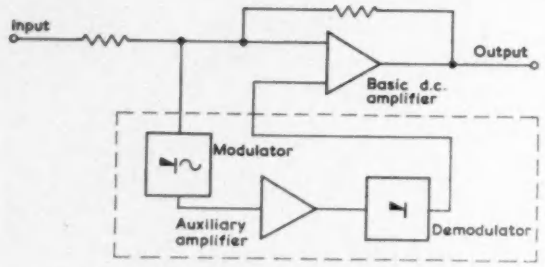

Fig. 2. 'Scaling' amplifier for analogue computer

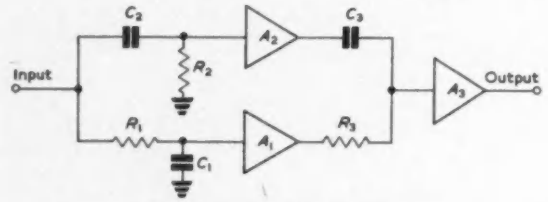

Fig. 3. The 'parallel T' amplifier

figuration the 'parallel-T' amplifier, and his basic arrangement is shown in Fig. 3; A_1 is the d.c. and low frequency amplifier. A_2 is the high frequency amplifier, and A_3 the output amplifier. The time-constant C_1R_1 is chosen to effect attenuation of signals at or near chopper frequency, C_2R_2 is the normal CR coupling of the a.c. amplifier and C_3R_3 is the frequency response crossover time-constant. Buckerfield showed that special proportioning of these three time-constants could produce amplitude and phase responses which were suitable for the application of overall feedback to the amplifier. His experimental amplifier had a drift figure of 1mV and a bandwidth extending into the kilocycles per second region.

Subsequent to Buckerfield's work, an amplifier[4] of improved performance was designed in the U.S.S.R. for analogue computing.

An Amplifier for Instrumentation

The amplifier to be described was designed in the U.S.A., and is a parallel hybrid amplifier. Use of a large degree of overall negative feedback, together with careful attention to detailed design, has resulted in an amplifier of extremely good performance.

In the block diagram Fig. 4, the input signals are fed to the input summing junction SJ_1 via the input feedback resistor R_f. The high frequency amplifier A_2 accepts signals of frequency above 1c/s, while d.c. and low frequency signals are fed via the chopper into the d.c. channel A_1. After demodulation, the d.c. and l.f. signals are recombined via C_3 and R_3 with the h.f. content, and fed to the output amplifier A_3 which is directly coupled. Negative feedback is applied via resistor R_f, and the degree of feedback controls the forward gain of the system in the normal manner.

Circuit Description

The circuit diagram of the amplifier is shown in Fig. 5.

The signal components of frequency greater than about 1c/s are fed to the grid of V_{3a}, which is a special quality low noise double triode. To minimize the problem of spurious synchronous signals, the heater of this valve and V_4 are d.c. energized. From V_{3a}, the h.f. signals are fed via C_7R_{50} to pentode V_4, and the open gain of the a.c. amplifier from V_{3a} grid to V_4 anode is approximately 79dB at 1kc/s. From the input summing junction, the d.c. and low frequency signals are fed to the chopper via R_{45}, and the chopper operating at 50c/s grounds the input of the d.c. channel on alternate half cycles. The resulting square wave is amplified in the two triode stages V_{3b} and V_{8a}, and finally applied to a bottomed pentode V_{8b} which limits the peak distortion appearing on the signal. From the pentode anode, the signal passes to a driven diode demodulator and thus to the combined signal summing junction via R_{16}. The overall gain of the d.c. channel is 105dB.

The combined signal is applied to the grid of pentode V_5 which, together with V_6 and V_7, forms the directly coupled wideband output stage. V_6 and V_7 combine in a bridge circuit to form an efficient cathode-follower which sets its reference voltages with respect to one cathode of V_6 which is connected to the common rail. In order to operate correctly, the output stage requires an entirely separate h.t. system, and this h.t. system also provides a zero-setting potential fed into the input chopper via the balance control RV_1. The output amplifier has a d.c. gain of 46dB.

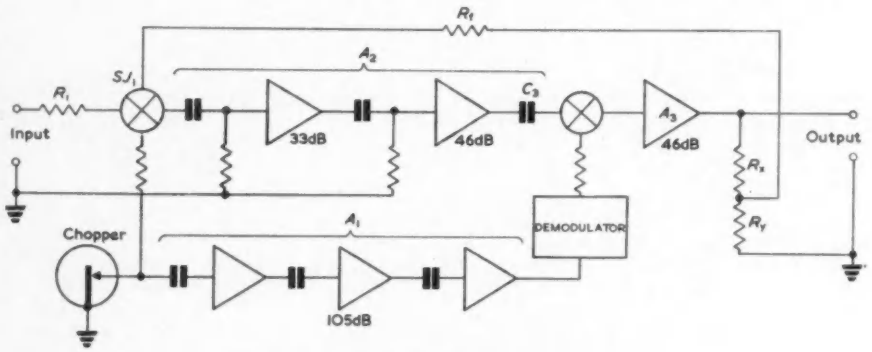

Fig. 4. The arrangement of the amplifier

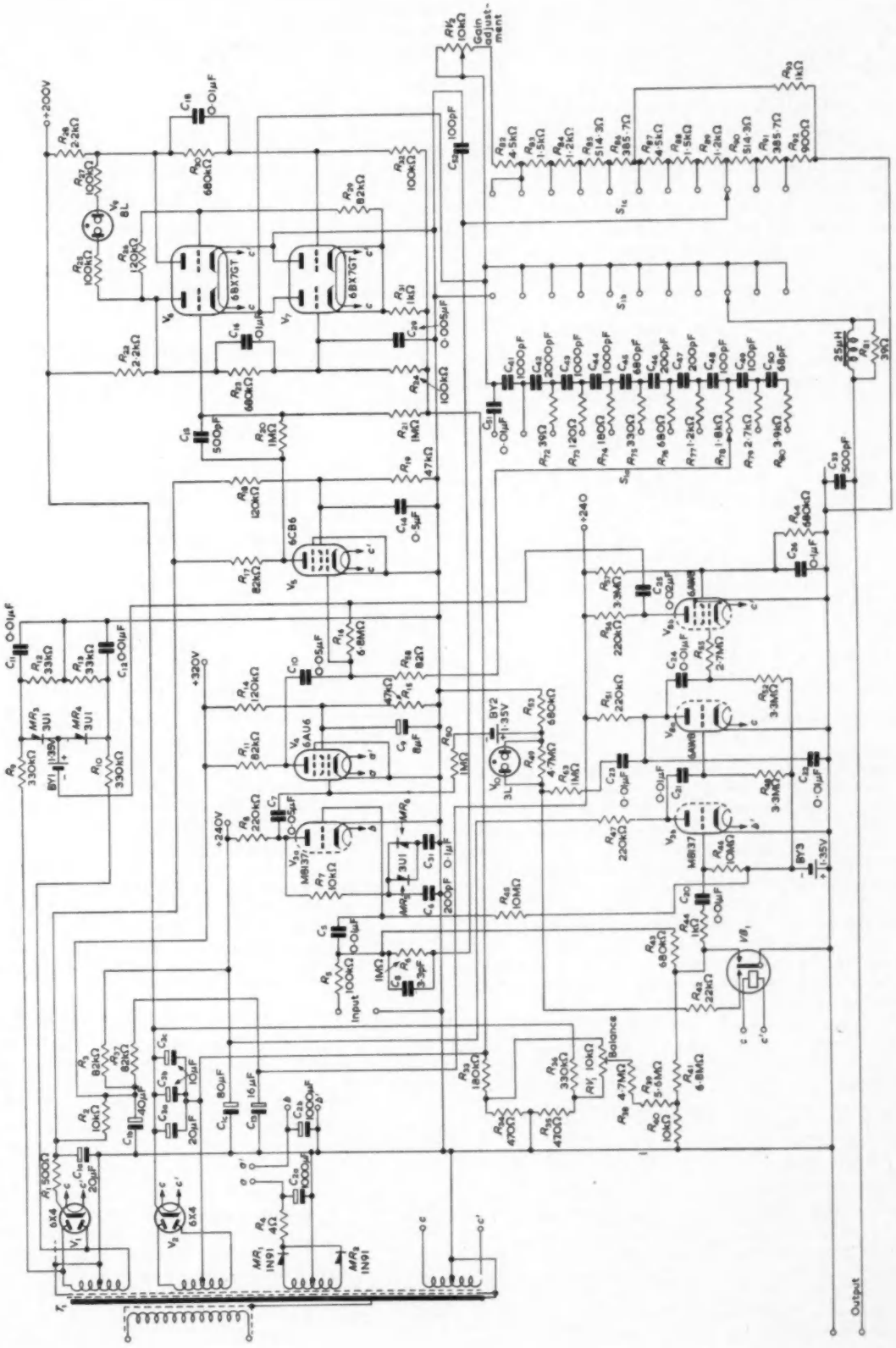

Fig. 5. The amplifier circuit

The neon indicator V_9 is intended to indicate an impending current overload on the amplifier, and in the event of overload, the effects are somewhat reduced by the limiting diodes connected to V_{2a} anode, and by the coupling circuit C_{23}, R_{49}, R_{53}, etc. between the d.c. and a.c. channels. Normally, a portion of chopped signal is rectified by the second contact of the chopper, and forms part of the bias voltage of V_4, filtering being accomplished by R_{49}, R_{50} and C_7. If overload occurs, the neon lamp V_{10} strikes and increases the bias component, thus tending to discharge C_7 and reduce the overload effect.

Overall negative feedback is applied via R_5 and R_6, and change of forward gain of the complete unit is achieved by controlling the return point of R_6. This feedback network is shown schematically in Fig. 6 and the gain is approximately

$$-(R_6/R_5).\frac{R_x + R_y}{R_y}$$

The approximation is very close (± 1 per cent, d.c. to 2kc/s) because of the large degree of feedback, e.g. forward gain × 1 000, d.c. feedback 86dB.

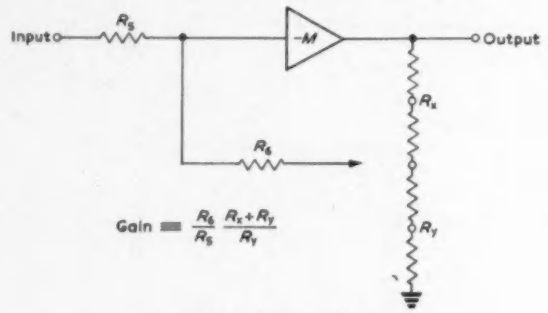

Fig 6. Feedback network schematic

To avoid instability when only requiring low forward gain, a.c. feedback is applied over the output amplifier, this feedback loop control being ganged with the forward gain control. The C_8 and R_7 time-constant in V_{2a} anode circuit also controls the h.f. response of the a.c. channel. The a.c. feedback around the output stage is applied in such a manner that the combined signal junction forms a null, the basic input feedback impedance being the source impedance at V_4 anode. This overall a.c. feedback implies that, at low forward gains, the a.c. gain of the output amplifier is falling rapidly, and early stage overloading prevents the full output swing being available at the high frequencies.

The h.t. supplies, although adequatelv filtered, are not stabilized, since the large degree of negative feedback removes the necessity. Bias requirements are met by miniature cadmium cells, BY_1, BY_2, BY_3.

The appendix gives brief details of the amplifier performance.

Physical Construction

The amplifier is intended as a unit module which may be installed either singly in a cabinet, or with other modules in a 19in rack system.

As the circuit shows, the power supply is integral with the amplifying circuits, although it is concentrated to the rear of the chassis. The chopper is mounted at the front of the unit on a shock mounted isolated chassis. The valves are also carried on a separate chassis with shock mounts, while the majority of small circuit components are installed on etched wiring boards within the main chassis frame. The feedback components are built into an assembly surrounding the control switch at the front of the amplifier.

Connexions to the amplifier are made by a multi-way slide-in connector at the rear of the amplifier. This connector mates with its complementary part when the amplifier is slid into its housing. The housing also contains an extractor fan which draws air into the front of the amplifier, over the valves, and out at the rear; this ventilation keeps the chopper at external ambient and reduces the possibility of thermal drift.

A photograph of an amplifier of the type described now being made in the U.K. is shown on page 437.

Conclusion

The amplifier described, although originally designed for instrumentation use, typically in strain-gauge installations, can be used in many other applications.

Amplifiers of this type have been used for analogue computing, as oscilloscope pre-amplifiers, and with indicating meters can be used as high sensitivity d.c. voltmeters.

Acknowledgments

The author wishes to acknowledge the assistance given by the engineering staff of Kin Tel, U.S.A., particularly that of W. S. Ivans, Jr., Vice-President, in the U.K. development programme.

He also wishes to record his thanks to the Directors of Solartron Research & Development Ltd, for permission to publish this article, and to his colleague, S. Heinemann, who carried out much of the measurement work during the programme.

Appendix

Performance Specification

The following brief review of the specification is given with comments:—

Gain—Typical open loop d.c. gain—146dB. Closed loop gains with built-in feedback control 20, 30, 50, 70, 100, 200, 300, 500, 700 and 1 000 with continuous 1 to 2 times variation by fine control.

Gain Accuracy—± 1 per cent d.c. to 2kc/s. The basic feedback attenuator is largely composed of wire-wound components, and the high degree of feedback ensures that gain accuracy and stability are almost completely dependent on the values of these components. The short term gain stability is 0·1 per cent.

Input Impedance—100kΩ.

Output Impedance—Less than 1Ω in series with 25μH.

Equivalent Input Drift—After warm up, less than ± 2μV over 40 hours of operation when used on regulated a.c. supply. ± 10 per cent change in a.c. supply voltage causes less than ± 5μV change.

Equivalent Input Noise—D.C. to 3c/s. Less than 6μV peak-to-peak.

D.C. to 750c/s. Less than 5μV r.m.s.

D.C. to 50kc/s. Less than 12μV r.m.s.

Chopper Intermodulation—Less than 0·1 per cent. Although there is no synchronous signal rejection at the input to the d.c. amplifier, the large degree of feedback reduces the output level of intermodulation components.

Linearity—Better than 0·1 per cent to 2kc/s at full output. The figure is consistent with at least 60dB of the

feedback. The linearity at d.c. (80dB of feedback) is typically 0·01 per cent.

Output Capability—± 35V peak into 1kΩ.
±45V peak into loads greater than 10kΩ.
±40mA into loads from 10Ω to 400Ω.
Loads lower than 10Ω tend to reduce the effective overall feedback. The a.c. output capability is limited on gains below 300 above a frequency of 5kc/s. Maximum capacitive load 0·5μF.

Frequency Response—± 3 per cent to 10kc/s.
Less than 3dB down to 40kc/s.
Rise-time less than 10μsec to 1 per cent.

Power Requirement—115V or 230V a.c. 50/60c/s. 75VA.

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H.F. Coil Winding Machine

A new machine for winding h.f. coils and i.f. transformers is now being manufactured by Work Study Equipments of 4 Woodman Lane, Sewardstonebury, Essex. It is claimed that productivity increases of the order of 500 per cent can be attained compared with the existing methods used in the radio industry.

Known as the ROTAWINDER it is designed to wind a precise number of close wound turns of wire on to a former; the basic machine will wind any number between 1 and 30 turns.

The machine consists of a floor standing frame, upon which are mounted the winding head and former indexing table. These two units are mechanically independent of each other, but are pneumatically interlocked, so that the table presents a new former to the winding head as soon as winding of the previous former is completed.

Motive power for the winding head is provided by a pneumo-hydraulic cylinder unit, which drives a train of gears via a rack, to impart rotary motion to a hollow mandrel, down which the wire passes, and from thence to the winding arm which describes a circular path about the axis of the stationary former mounted on the table. A non-return clutch is incorporated in the gear train to ensure that the winding arm only rotates on the down-stroke of the piston and releases itself on the upstroke, so that the coil cannot be partially unwound. This factor and the positive stops which come into action at the end of each winding stroke ensures that completely wound coils are obtained every time and the wire is always in exactly the right position to be picked up by the next coil as the table indexes. The number of turns wound on to the former is controlled by the piston stroke which can be varied by moving the stop to give increments of one turn. The rate of winding is also variable by a throttle valve in the hydraulic circuit which controls the piston speed.

Wire is fed to the winding arm via the hollow mandrel from a stationary bobbin and passes through an adjustable tension unit immediately prior to entry into the mandrel. This independent tension device obviates the usual difficulties experienced when braking is applied to a rotating bobbin and the varying torque effect produced as wire is removed. Corners, at which the wire changes direction, are shielded by glazed ceramic rings which apart from reducing random friction effects to a minimum, ensure that the wire insulation is undamaged as it passes through.

The indexing table consists of a seven station jig for the formers which is pneumatically rotated in sequence with the winding head piston.

The primary loading station is located immediately in front of the operator who slips a former into the slots provided for the end cheek or, in the case of formers without cheeks, on to a peg. The second station can also be used for loading if due to a faulty former or other cause the operator is unable to load the primary station in the winding cycle which takes place at the third station. After winding the former indexes to the fourth station where it is heated to bond the wire to the former and then it passes successively to the fifth and sixth positions where it is cooled prior to parting off and ejection at the seventh.

Each station is fitted with an adjustable wire guide which picks up the wire from the winding head and lays it over the former to be wound as the table rotates. Adjustment of these guides determines the position on the former at which winding commences, which, once locked, becomes invariable and exact duplication of results is ensured. The wire guide performs a dual function in that it acts as an anvil against which the wire is parted at the seventh station by means of a guillotine actuated by a small supplementary cylinder. This guillotine is interlocked with the indexing mechanism so that jamming is impossible.

Once the wire guides have been set to give the starting position required, repetitive accuracy is solely a function of the tolerance in the wire itself e.g. a change in wire diameter will only affect the length of the coil and not the point at which it starts or the number of turns which is always an exact multiplication factor of unity.

The heater which bonds the wire in the fourth indexing position derives its current from a transformer which drops the voltage to 45 volts thus lowering the danger factor due to a wire breaking and touching the element to a safe figure from the operator point of view. After cooling in the fifth and sixth positions the wire is positively locked on to the former and is unable to unwind or spring and when ejected at the seventh position the coils have two free ends approximately two inches long for soldering to the former cheek tags in a subsequent operation.

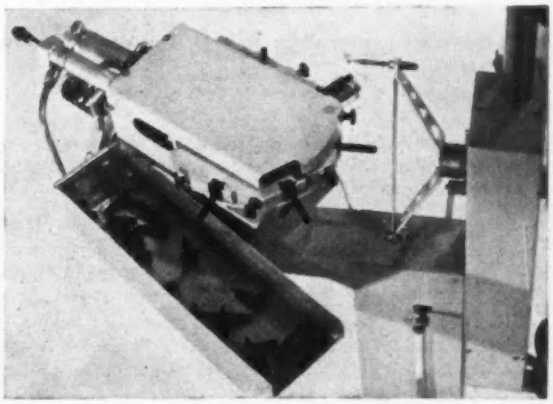
By resetting the machine or passing to another, a further coil can be wound on the same former thus making the ROTAWINDER suitable for the production of either tuning or i.f. coils.

The machine is available in two forms mechanically similar but with differing pneumatic circuits.

The semi-automatic type is operated by depressing the pedal momentarily which then stays depressed until winding, which commences immediately, is completed. The winding piston operates a valve at the end of its stroke which returns the pedal and the piston ready for the next cycle which will not commence until the pedal is reoperated. If the pedal is held depressed winding will be completed but the winding piston will not return and the table will not index until it is released.

The cycling type is designed to automatically wind and index all the time the pedal is depressed. The sole requirement for the operator is the placing of formers in either No. 1 or 2 index position at the rate of winding which can be stopped at any time by releasing the pedal.

The winding head of the h.f. coil winder



The Theory of Negative-Feedback Voltage Amplifiers

By C. H. Vincent*, M.Sc., Ph.D., F.Inst.P., M.I.E.E.

A slight modification is made to the standard method of analysis of negative-feedback voltage amplifiers. This modification involves recognition of the fact that the attenuated feedback voltage cannot always be subtracted directly from the input terminal voltage in practice, as commonly assumed in the theory. This is because some form of mixing circuit must normally be used. Once this is recognized, it becomes easier to apply the general analysis to any particular circuit without special treatment.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

IN a negative-feedback amplifier, there are three vital points at which the voltages existing are of particular interest. These are the input terminals, the output terminals and the first point at which the combined input and negative-feedback voltages appear at the input end of the amplifier. Let these be denoted by *I*, *O*, and *P*, respectively. Let the input terminals to the feedback attenuator be denoted by *F*. This point is, of course, linked to *O* in the normal operation of the feedback amplifier. Finally, let *F'* denote the input terminals of a dummy load which may be used to present the same load impedance to *O* as do the feedback attenuator terminals at *F*. (It is assumed here that if this impedance is not so high that the loading may be neglected altogether, it at least has a known constant effective value. This is true to a high degree of accuracy in almost all practical cases. If this assumption is not made, the mesh equations must be used.)

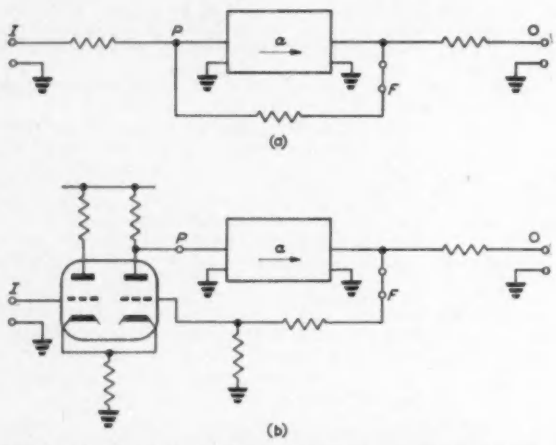


Fig. 1. Typical feedback arrangements for which direct subtraction of the feedback voltage does not apply

Assume that the exact analysis, for a finite resistance in the cathode circuit of the mixing valve, is called for in case 1(b)

Two common defects found in standard textbook treatments of the feedback amplifier are as follows:

(a) No clear distinction is made between the input terminals *I* and the point *P*.

(b) It is taken for granted that the attenuated feedback voltage βV_o may be subtracted directly from the input voltage V_i by some suitable form of interconnexion, whereas this is often physically impossible.

The direct subtraction of the feedback voltage from the input voltage is only possible in certain special cases. (The ordinary simple cathode-follower is one such case.) Figs. 1(a) and 1(b) show two of many typical cases in which such subtraction does not apply. It is not possible because each signal concerned appears in a non-floating form between a live terminal and earth. It will be observed that the points *I* and *P* are quite distinct in each of the cases shown. It is obviously desirable that a general theory should be used which covers all cases, not just some of them.

All such cases can be covered in an unambiguous manner if the feedback amplifier is regarded as shown in Fig. 2. It is then considered in two parts, one being an attenuator and mixer with two inputs and one output and the other comprising the main amplifiying stages.

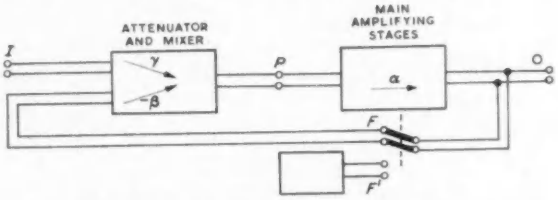


Fig. 2. General representation of a negative feedback voltage amplifier

α is then defined as the gain from *P* to *O* with *O* connected to the dummy load at *F'*.

(α must be negative in Fig. 1(a) and positive in Fig. 1(b)).

$-\beta$ is defined as the gain from *F* to *P* with the loop open at *F* and with a constant voltage at *I*.

(β is negative in Fig. 1(a) and positive in Fig. 1(b)).

γ is defined as the gain from *I* to *P* with the loop open at *F* and with a constant voltage at *F*.

(γ is positive in both Fig. 1(a) and Fig. 1(b)).

It follows immediately that with the loop closed:

$$V_p = \gamma V_i - \beta V_f$$
$$= \gamma V_i - \beta V_o \quad \ldots\ldots\ldots\ldots \quad (1)$$

This fundamental equation applies whether the main amplifier is distortion-free or not. Assuming that it is, then with a gain α:

* *United Kingdom Atomic Energy Authority.*

$$V_o = \alpha V_p$$
$$= \alpha\gamma V_1 - \alpha\beta V_o$$

Therefore:

$$V_o = \frac{\alpha\gamma}{1 + \alpha\beta} V_1$$
$$= \gamma/\beta \frac{1}{1 + 1/\alpha\beta} V_1 \quad \ldots\ldots\ldots (2)$$

This equation differs from the standard result only in the presence of the factor γ for the gain between I and P, but the method does make it much easier to avoid confusion. It is, of course, always possible to find 'equivalent' values of α and β to give the correct answer and make $\gamma = 1$ or to find some manipulation for the particular circuit (as demonstrated by Thompson[1] for Fig. 1(a)) which achieves the same end. The present method has the advantage that the points I, P, O and F are clearly defined for any multi-stage feedback amplifier and that the calculation of the gain for feedback proceeds in a straightforward manner from the open-loop gains. In Fig. 2 each interconnexion has been shown as a pair of lines, to include all possible cases. A common special case is for one line of each pair to be earthed, as in Figs. 1(a) and 1(b). Another special case occurs in the ordinary cathode-follower. In this case, one of the P leads is common with one of the O leads and direct subtraction of the feedback voltage is possible. (An ordinary cathode-follower circuit, redrawn to conform with Fig. 2, is shown in Fig. 3.)

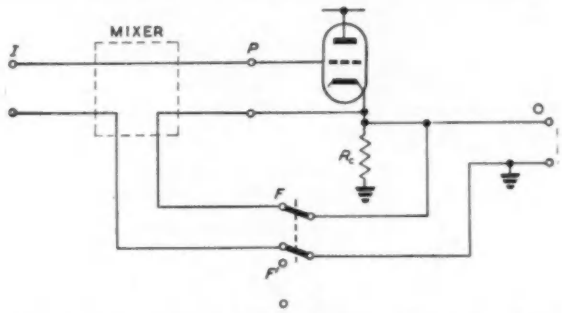


Fig. 3. Circuit of an ordinary cathode-follower rearranged in accordance with Fig. 2

The standard formula for the output impedance of a feedback amplifier can be shown in the usual way to apply without modification, as follows. Let the output impedance at the point O in Fig. 2 be Z_o ohms with the connexion made to the dummy load. A further load with impedance Z_L ohms will reduce the effective gain α by a factor $Z_L/(Z_L + Z_o)$. The overall gain with the feedback loop closed is then given by:

$$\gamma/\beta \frac{1}{1+(1/\alpha\beta)(1+Z_o/Z_L)} = \gamma/\beta \frac{1}{1+(1/\alpha\beta)+(Z_o/\alpha\beta Z_L)}$$

The overall gain is decreased by the factor $Z_L/(Z_L + Z_{OF})$, where Z_{OF} is the output impedance with the feedback loop closed, and this must therefore equal:

$$\gamma/\beta\,(\gamma/\beta)^{-1} \frac{1 + (1/\alpha\beta)}{1+(1/\alpha\beta)+(Z_o/\alpha\beta Z_L)} = \frac{Z_L}{Z_L+Z_o/(1+\alpha\beta)}$$

Therefore:

$$Z_{OF} = \frac{Z_o}{1 + \alpha\beta} \quad \ldots\ldots\ldots\ldots (3)$$

The usual arguments showing the reduction of frequency and amplitude distortion apply equally, with equation (1) replacing the corresponding standard equation in which $\gamma = 1$. All these results are to be expected, since the overall feedback amplifier with any value of γ is precisely equivalent to a feedback amplifier with the same values of α and β but with $\gamma = 1$, preceded by an ordinary amplifier of gain γ.

The method may be illustrated with the circuit shown in Fig. 4, which originated the correspondence leading to the present article. (This circuit appeared in a previous article[2]). In this circuit the gain of V_1 for pulses is:

$$-g_1\,(1/R_6 + 1/R_4 + 1/r_1)^{-1} = -g_1R_6' \text{ say}$$

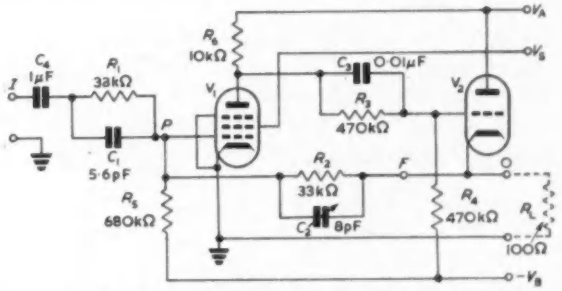


Fig. 4. Basic circuit of the anode-cathode follower with typical circuit values

where g_1 and r_1 are the transconductance and anode resistance, respectively, of V_1 and $1/R_6' = 1/R_6 + 1/R_4 + 1/r_1$. The gain of V_2 (taking the effective loading by the feedback circuit to be that due to a resistance R_2 at F, in view of the virtual earth at P) is:

$$g_2\,(g_2 + 1/R_L + 1/R_2 + 1/r_2)^{-1} =$$
$$(1 + 1/R_Lg_2 + 1/R_2g_2 + 1/\mu_2)^{-1}$$

where g_2, r_2 and μ_2 are the transconductance, anode resistance and amplification factor, respectively, of V_2. Therefore:

$$\alpha = -R_6'g_1\,(1 + 1/R_Lg_2 + 1/R_2g_2 + 1/\mu_2)^{-1}$$

Also:

$$\beta = -(1/R_2)\,(1/R_1 + 1/R_2 + 1/R_5)^{-1}$$
$$= -(1 + R_2/R_1 + R_2/R_5)^{-1}$$

and:

$$\gamma = (1/R_1)\,(1/R_1 + 1/R_2 + 1/R_5)^{-1}$$

(All the above gain formulae are rapidly and conveniently obtained by regarding the source of signal as a current source in each case.)

The overall gain with feedback is therefore:

$$\gamma/\beta \frac{1}{1 + (1/\alpha\beta)}$$
$$= -(R_2/R_1)\,[1 + (1/R_6'g_1)\{1 + 1/R_Lg_2 + 1/R_2g_2 + 1/\mu_2\}$$
$$\{1 + R_2/R_1 + R_2/R_5\}]^{-1}$$

as stated in the previous article. (The negative sign is appropriate in view of the inversion of the signal which occurs.) Putting $R_L = \infty$ in this gives the gain without any external loading.

The exact formula for the output impedance follows from equation (3) as:

$$(g_2 + 1/R_2 + 1/r_2)^{-1}$$
$$[1 + R_6'g_1\,(1 + 1/R_2g_2 + 1/\mu_2)^{-1}\,(1 + R_2/R_1 + R_2/R_5)^{-1}]^{-1}$$

which equals:

$$\frac{(1 + R_2/R_1 + R_2/R_5)}{R_6' g_1 g_2}$$

as given in the previous article, when the relatively small first term 1 in the square bracket is dropped.

While the method described above is intended to assist in the analysis of more complicated feedback circuits, and tells nothing new about the ordinary simple cathode-follower, it is of interest to apply it to the latter, as an example of its general applicability, as shown in Fig. 3. In this case, $\beta = 1$ and $\gamma = 1$. The gain from P to O with the feedback loop open is the gain of the valve as an ordinary amplifier, but is positive with the load at the cathode. That is:

$$\alpha = g(1/r + 1/R_c)^{-1}$$

where g and r are the transconductance and the anode resistance of the valve, respectively. Also:

$$Z_o = (1/r + 1/R_c)^{-1}$$

These give an overall gain:

$$G = \frac{1}{1 + 1/\alpha\beta}$$

$$= (1 + 1/\mu + 1/R_c g)^{-1}$$

and an output impedance:

$$Z_{OF} = \frac{Z_o}{1 + \alpha\beta}$$

$$= \frac{(1/r + 1/R_c)^{-1}}{1 + g(1/r + 1/R_c)^{-1}}$$

$$= (g + 1/r + 1/R_c)^{-1}$$

in accordance with the usual formulae.

It is appreciated that feedback amplification is a field in which most people have their own preferred methods of approach, which are easier and clearer to them through repeated use. Nevertheless, it is hoped that the modification described above may be found to simplify the problem of applying the well-known standard theory of negative feedback voltage amplifiers to a variety of particular cases without requiring individual special treatments at the input end.

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A Blood Cell Counter

By G. P. Burn* and P. J. Tosh*

This article describes Coulter's method for counting blood cells. The apparatus enables 10 000 cells to be counted in about a minute, using Dekatrons. The technique is simple and reliable.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

A BLOOD cell is about 0·007mm diameter. Its electrical conductivity is slightly lower than that of the surrounding solution. When the cell passes through an aperture of a comparable size, the conductivity of the aperture changes to a significant extent. The electrical pulse so generated can be amplified and recorded. This principle was discovered by Coulter[1].

Apertures of comparable size are given by the pivot holes of watch jewels, which may be obtained in various sizes down to 0·05mm diameter. The jewel is sealed into the side of a glass tube[2]. The tube is filled with 0·9 per cent sodium chloride solution and immersed in a sufficiently dilute suspension of blood cells in saline. When suction is applied to the open end of the tube, blood cells are sucked through the aperture one by one.

Current is passed through the aperture by means of two platinum electrodes, one inside the tube and the other in the cell suspension. For an aperture of 0·1mm diameter a current of 0·8mA is suitable: a single blood cell then gives a pulse of about 25μV, the resistance of the aperture being about 5kΩ.

Pulse Shape

The shape of the pulse deserves some comment. It is convenient to pass about 0·5ml of blood cell suspension through the aperture in about 30sec. This represents a linear rate of flow of 2 500mm/sec through the aperture. Now the aperture is about 0·1mm long so the blood cell is detected for about 40μsec. In practice the potential across the aperture begins to rise as soon as the blood cell approaches within about 0·1mm and reaches a maximum when the cell enters; the potential remains constant while the cell is passing through the aperture, and then it falls away as the cell leaves the other end. The consequence is that the pulse has a flat top, which requires such a good low frequency response in the amplifier for its correct reproduction that the signal is swamped by 50c/s mains pick-up. The low frequency response is therefore restricted so that the mains pick-up is negligible, and the pulse is distorted by the amplifier. However, the leading edge of the pulse is sufficiently well defined to operate the scaler.

The circuit is shown in Fig. 1. The input terminal of the amplifier is connected to the platinum wire in the blood cell suspension, the interior of the glass tube being at earth potential.

A one-inch diameter oscilloscope is provided to monitor the pulses at the output of the amplifier because the waveform gives warning of partial blockage of the aperture, by cell debris or dirt.

The scaler consists of a series of five Dekatrons. The circuit follows standard practice[3].

Operation

The jewel aperture, mounted in its glass tube, is con-

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nected to a glass manifold by a B14 ground glass joint (see Fig. 2). The manifold is filled with saline from the reservoir. An arm on the manifold connects through a further ground glass joint to a control tube containing mercury and the 'start' and 'stop' contacts. In use the syringe tap is opened, the waste and saline reservoir taps being closed and the piston of the syringe is withdrawn. Suction is thereby applied within the rigid manifold and

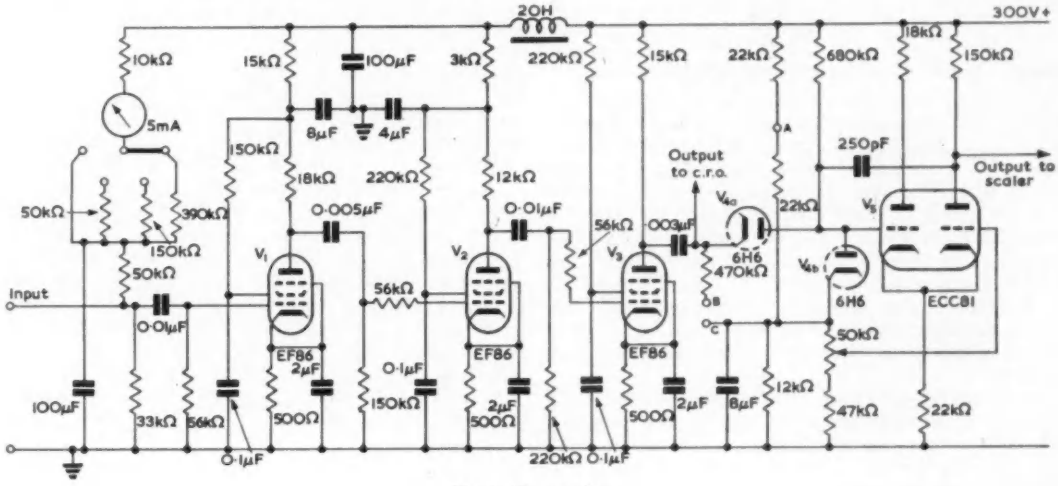

Fig. 1. The amplifier

When the mercury reaches the 'start' contact, point B is connected to point C removing the bias across V_{4a} and opening the gate. Negative-going pulses are passed to the pulse shaper V_5. When the 'stop' relay operates point B is again connected to point A.

Calibration Curve

When the blood cell concentration is high it is possible

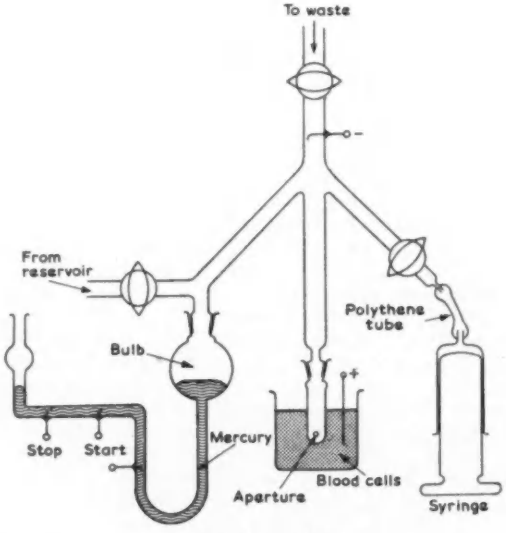

Fig. 2. Glass manifold

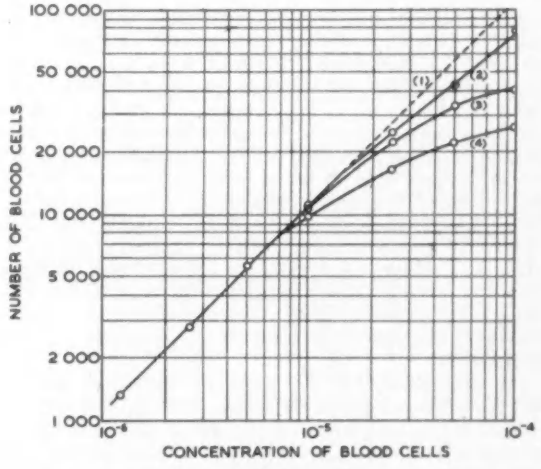

Fig. 3. Calibration curves

Curve 1, shown dotted, is the linear extrapolation from the results obtained with low concentrations of blood cells; Curve 2 was obtained with an aperture of 0·1mm diameter; Curve 3 with an aperture of 0·18mm diameter; Curve 4 with an aperture of 0·25mm diameter

mercury is drawn up into the bulb: the other end of the mercury breaks both the contacts. Electromagnetic relays are connected to these contacts and when they are both released point B (in Fig. 1) is connected to point A, making V_{4a} cathode about 120V positive with respect to its anode. As the gain of the amplifier is only about 200 000, the output pulses are about 5V and cannot influence the anode of V_{4a}: that is to say the gate is shut.

Now the syringe tap is closed, the scaler is reset to zero, and the mercury in the bulb runs back into the control tube under its own weight, drawing an equal volume of blood cell suspension through the aperture. for two cells to enter the aperture at the same time. Although the magnitude of the pulse should be greater, the apparatus cannot detect this and so only one cell is counted. Consequently there is a loss of counts by coincidence at high cell concentrations. Fig. 3 shows three experimental curves obtained with apertures of different sizes—the larger the aperture the greater the loss of counts.

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Characteristics and Applications of Glow-Discharge Tubes

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(Part 2)

(Voir page 405 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 412)

Impedance Characteristics and Hollow-Cathode Tubes

When a small alternating voltage is superimposed on the steady operating voltage of a glow-discharge tube, the impedance presented to the alternating signal is found to increase with frequency. The impedance has inductive and resistive components at audio frequencies, but the reactance is capacitive at higher frequencies of the order of 1Mc/s. Measurements to determine impedance-frequency characteristics, in the audio-frequency range, of tubes with various neon-argon gas fillings, showed that the effective series inductance decreased and the resistance increased with increasing frequency over the range 300c/s to 30kc/s and both components decreased with increasing tube current[7].

Various attempts have been made to explain such results qualitatively in terms of the basic process in a glow discharge. It has been suggested[46] that the inductive component of the impedance is associated with the nature of conduction in the discharge, i.e., as the current varies, the degree of ionization in the gas changes correspondingly, but there is a delay, due to the small mobility of the positive ions, before the degree of ionization reaches the new value. Williams[47], however, states that the alternating electric field will have very little effect on the maintenance of the discharge, and he attributes the inertia effect to the damped motion of current carriers. A charged particle moving in a steady electric field, superimposed with a small alternating field, produces a current in the external circuit, which depends only on the average drift velocity, and the drift velocity due to the alternating field only bears a close resemblance to an electrical network containing inductance and resistance. Williams' considerations do not explain, however, the impedance characteristics at higher frequencies, and they necessitate the introduction of a capacitance, greater than the inter-electrode one, to account for the impedance peak observed at high frequencies.

An early theory by Van Geel[48] was derived by considering perturbations about the steady-state maintenance condition, and by assuming that physical quantities in the discharge (i.e. space-charge, etc.) can be regarded as functions of the instantaneous current and voltage alone. This theory predicted that the impedance loci should be half circles if the displacement current is neglected[49]. Van Geel[50,51] has since extended the theory and postulated the form of the impedance locus when a secondary mechanism, having a delay time, is present in the discharge. The physical quantities in the discharge can now be regarded as functions of the instantaneous current and voltage and a parameter P which is considered to be a retarded function of current and voltage.

It has been suggested by Yeh[52] that there may be a correlation between the frequency at which the glow-discharge tube reactance changes over from inductive to capacitive, and the positive-ion transit time in the cathode-fall region of the discharge. Benson and Gillespie[6] have shown how the transit time of the positive ions may be calculated if certain parameters of the discharge are known, but they had difficulty in comparing their experimental results with the theory because reliable figures for the various constants involved were not available for their particular tubes.

In more recent investigations[53] it was decided to measure the impedance characteristics over the frequency range 300c/s to 5Mc/s in order to obtain the equivalent circuit of a glow-discharge tube and to test the validity of Yeh's suggested correlation. It has been found that the complete impedance locus of a glow-discharge tube can be explained effectively by Van Geel's theory if it is extended to include several delay times. The delayed effects in a glow discharge affect the impedance at low frequencies considerably and the complete equivalent circuit is much more complicated than the one usually quoted[4]. The equivalent circuit can

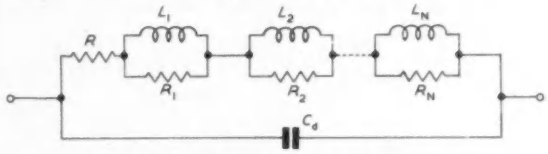

Fig. 8. Equivalent circuit of a glow-discharge tube

be identified from the form of the impedance locus and can be regarded as a series combination of the static resistance (slope of the static characteristic) and a number of parallel combinations of inductance and resistance (Fig. 8). Each parallel combination has a time-constant associated with a particular process in the discharge mechanism. At frequencies above 3Mc/s the effective tube capacitance is independent of frequency and is less than the cathode dark-space capacitance[53].

Impedance measurements on glow-discharge tubes have also been carried out by Ahsmann and Oskam[54]. They have observed that the complex impedance of the glow discharge in a rare gas is considerably reduced by the addition of another rare gas of lower ionization potential, in fact, both the real and imaginary parts decrease. They have also found that the impedance is nearly independent of the anode distance provided an anode fall does not develop. Apart from the influence on the impedance, the addition of one rare gas to another of higher ionization potential, strongly influences the recovery time of the discharge.

Other impedance measurements have been reported by Ahsmann[55,56] and Marx[57].

An interesting paper by Townsend and Depp[58] describes some of the characteristics of cold-cathode tubes which have been developed for use as switching elements in series with voice-frequency telephone transmission circuits. The usefulness of a tube may be severely limited for such purposes unless the impedance presented to a.c. signals over the audio-frequency range is low. Townsend and Depp first discuss the modifications which may be made to the voltage-current characteristic of a tube by changing

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the geometry from a single-plane cathode to a hollow cathode, and they give some information about the effects of varying anode-cathode spacing in a tube.

In the case of plane-cathode tubes (e.g. Western Electric type 313C, containing 99 per cent neon and 1 per cent argon and having a cathode of barium and strontium oxides) at a fixed frequency, it is found that the resistive component decreases with current approximately inversely as the square root of the direct current I_{dc} ($R = 1\,080/\sqrt{I_{dc}}$) and the inductive reactance X varies with I_{dc} according to the law $X = 22 + 1\,450/I_{dc}$. It might be thought therefore that to get low resistive components the direct current through the tube should be further increased. However, in this range of current, the life of a tube varies approximately as $1/(I_{dc})^2$, while the resistive component varies as $1/(I_{dc})^{\frac{1}{2}}$.

An experimental tube which had a cathode area about six times that of the type 313C was then examined by Townsend and Depp[58]. This change of cathode area, together with the necessary change in anode geometry, led to an impedance reduction of about five times. At a constant current and with a given cathode area the resistive component of impedance was found to decrease with increase of gas pressure (p), at a fixed temperature, approximately in accordance with the relation $R \propto 1/p^2$. Since the current density increases approximately proportional to p^2, the effective cathode area will tend to be reduced unless the total current is kept high enough to cover the cathode fully. It follows that with a fixed total current there is a limit to either increase in pressure or in cathode area. In a further search for low impedance a number of different gas fillings have been tried, including all the rare gases as well as several mixtures of them. No significant advantages were obtained by Townsend and Depp by the use of other than the more common neon and argon gas fillings.

It is seen therefore that the ability to control impedance characteristics of plane-cathode tubes by varying the tube parameters is limited. The possibility of producing tubes with plane cathodes having impedances of less than 10Ω or negative values seems remote. In view of this, Townsend and Depp studied the characteristics of some hollow-cathode tubes. By proper correlation of cathode geometry and gas density hollow-cathode tubes can be used to give a negative-resistance component of impedance. Townsend and Depp conclude from their work that cold-cathode tubes are potentially useful as electronic switches for use in series with voice-frequency transmission circuits.

More recently the characteristics of hollow-cathode tubes have been investigated by Townsend[59,60] and White[61,62]. Much of the early work with hollow cathodes has been done with V- or U-shaped structures or with circular cylinders. However, the high sputtering rate and the non-uniform flow of sputtered material within the hollow of such structures results in alteration of the internal configuration by the discharge. In addition large numbers of gas atoms are trapped in the sputtered material which accumulates in those parts of the cathode where the current density is low. White[62] has made an experimental study of the properties and characteristics of a glow discharge to a nearly spherical hollow cathode. Current densities in excess of 0·5A/cm² can be drawn from the cathode with negligible deterioration from sputtering. In neon the discharge exhibits a stable and reproducible negative voltage-current characteristic at currents of a few milliamperes. It has been found possible to scale the cathode dimensions provided the pressure p is adjusted to maintain pd_c a constant, where d_c is the cavity diameter. Discharges have been operated in cavities ranging from 0·05 to 2cm diameter. However, only if the current i is scaled so as to keep pi constant do scaled cathodes show similar discharge characteristics.

White[62] has experimented with a variety of materials and has found that refractory metals of low work function and high sputtering threshold make the most satisfactory cathodes. Materials that have been investigated include titanium, zirconium, hafnium, niobium, tantalum, molybdenum, tungsten, thorium, iron, nickel, copper, carbon, barium, barium oxide and lanthanum boride. Of these only the first eight will maintain a stable cavity discharge. The best materials from the point of view of discharge reproducibility and stability are niobium and molybdenum in that order. In Fig. 9 are plotted the running voltages in neon against published values[63] of work function ϕ for several cathode materials. The trend towards lower voltage with decreasing ϕ is in agreement

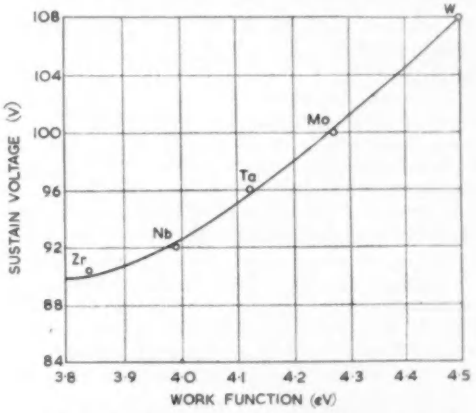

Fig. 9. Discharge sustain voltage against cathode work function for 0·075cm diameter cavity cathodes operating at 10mA in neon at 100mm Hg

with theoretical predictions concerning the behaviour of the secondary-electron ejection coefficient for positive ions γ, with work function[64].

A theoretical treatment of the spherical cavity cathode has been published by Allis[65]. For the high surface current densities occuring in the cavity cathode almost all the ionizations occur in the negative glow. Using the energy principle a simple equation can be derived for the cathode fall which predicts all observed variations with current in neon-argon mixtures.

A hollow-cathode glow-discharge operated in mercury vapour and using a spherical cathode cavity has been described by Hernqvist[66]. His studies were made as part of a research programme for generating millimetre-wave plasma oscillations.

Sputtering, Photo-electric Effects and Gas Clean-up

In high-stability reference tubes the cathode is made from carefully prepared molybdenum and is cleaned by sputtering the surface in a glow-discharge. Since the cathode may be contaminated by liberation of gases from the glass walls a layer of molybdenum is deposited on the glass. This is accomplished by continuing the cathode sputtering for a time after the cleaning operation. The sputtered molybdenum can act as a getter to absorb any gas liberated from the walls. The discharge itself liberates gases from the walls and the molybdenum layer serves as a shield between the glass walls and the discharge.

Fox[67] has observed that many commercial tubes show a considerable reduction in the mean statistical delay of breakdown when exposed to daylight. This is due to photo-emission and it occurs even though the electrodes and assembly are all made of high-work-function materials such as molybdenum and nickel. The emission is often attributed to a small amount of ultra-violet radiation reaching the electrodes after passing through the glass envelope. Simple tests show, however, that the emission occurs at wavelengths much larger than one would expect from the work function of the materials used. Measurements have shown that the photo-emitting surface in a discharge tube often has a work function as low as 2eV, the photo-electric threshold being approximately 6 000Å corresponding to yellow light.

Fox[67] has studied the occurrence of these low work-function surfaces in tubes containing molybdenum and tungsten electrodes with a gas filling of neon and a trace of argon at a few centimetres of mercury pressure. The photo-activity shown by tubes is thought to be due to sodium set free from the glass by electrolysis during the sputtering process.

The effect of light on the striking voltage of tubes has been discussed elsewhere[1,69-72] and the reduction of the cathode fall of a normal glow discharge by illumination of the cathode has been studied by Kluge and Schulz[73]. Decrease of striking voltage produced by external illumination in low-voltage neon lamps has been made use of in various circuits by Braunbeck[74]. A fairly recent paper on photo-sensitive neon-discharge tubes has been written by Dillon[75].

The successful application of the cathode-sputtering technique to trigger-tube manufacture has been described by Tosswill[76] and by Gimson and Crowther[77]. One of the tubes described by Tosswill[76,78] (Z800U) has been designed for use in a stabilizer circuit for Geiger counters in radiation monitors

Much has been written on the subject of sputtering in glow discharges. Wehner[79] has recently studied the influence of the angle of incidence on sputtered yields and Koedam[80,81,82] has sputtered single-crystal metals by bombardment with rare gas ions of low energy (50 to 350eV) and polycrystalline silver surfaces with argon ions (energy 40 to 240eV). Wehner bombarded small metal spheres with uniform ion beams and observed the changes in shape of these spheres after sputtering. He found that some materials behave quite differently from others. The angle effect is very pronounced with iron, molybdenum and tantalum, much less pronounced with nickel and tungsten and practically disappears with platinum, silver and gold. Koedam has observed that when the bombarded electrode is made of single-crystal material certain preferential directions are found for metal atoms leaving the surface.

Rol et al[83] have shown that the sputtering yield of copper monocrystals is quite different from that of polycrystalline copper and a new theory of cathode sputtering at high energy has been presented by Cassignol and Ranc[84].

There have been two interesting reviews of sputtering published lately by Guntherschulze[85] and Wehner[86] and recent theories of sputtering have been given by Henschke[87], Harrison[88-90] and Langberg[91,92].

A method has been described by Wheeldon[93] for measuring the absorption of argon by glasses. With all types of glass, absorption was only found to occur when a discharge was being passed. Below 300°C the rate of absorption was more or less independent of temperature and no absorption was observed if a tube was left standing or was heated at a temperature up to 250°C. If a tube which had already absorbed argon while running was then heated (without a discharge) to 350°C for several hours a substantial amount of the absorbed argon was evolved. The argon was re-absorbed on continuing the discharge. Wheeldon[93] presents a curve showing the way in which argon is absorbed by tubes made from different glasses. The rate of absorption is found to be quite sensitive to the glass surface conditions, but this has not been fully investigated.

Seigler and Dieke[94] have studied the clean-up of argon and less elaborately xenon.

Blodgett and Vanderslice[95] have investigated the clean-up of inert gases by a gas discharge. The clean-up of rare gases in a tube in which metal is being sputtered is governed largely by two factors. First, the rate at which the metal is sputtered, and secondly, the potential of the surface on which the metal lands. At small negative or positive potentials on the surface collecting sputtered metal there is a slow clean-up rate caused by uncharged species being buried by sputtered metal. At more negative potentials burial of ions becomes important and clean-up is much more rapid.

Bartholomew and La Padula[96] have performed experiments using Kr^{85} as a tracer in glow-discharge tubes with nickel cathodes running at 150V, 35mA in a neon-argon gas mixture. Kr ions were found to penetrate the cathode.

Other Characteristics of Glow Discharges

Rose[97] has reported the results of some experiments on discharge tubes to determine secondary-emission coefficients at the cathode surfaces. The experiments are mainly concerned with gas fillings of hydrogen and deuterium and values of the quantity γ (secondary electrons/incident positive ion) have been found. In addition an approximate measurement has been made of the effect of photons in maintaining glow discharges in hydrogen or neon. Telkovsky[98] has studied secondary-electron emission from targets of nickel, copper, zirconium, molybdenum, tantalum and graphite when bombarded with ions of hydrogen, helium, nitrogen, neon, argon etc.

A comprehensive study has been made by Davies et el[99] of the primary and secondary ionization coefficients in hydrogen and in the inert gases under uniform field conditions. A unified theory of breakdown and the glow discharge has been presented by Ward and Reddan[100] and the influence of metastable atoms on the stability of discharges has been discussed by Hutton[101]. Golant[102] has derived the mobility and Townsend coefficient for a d.c. discharge in argon. Cataphoresis, the collection of minority gas species at the cathode in a glow discharge, has been dealt with in papers by Loeb[103] and Riesz and Dieke[104].

Vasil'eva and Kaptsov[105] have observed the effect of varying several tube parameters on the difference between ignition and extinction voltages of a glow discharge. Experiments were performed with electrodes of nickel and aluminium and electrode separation, gas pressure and electrode shapes were varied.

The characteristics of glow-discharge tubes have been discussed by several other authors. Handly[106] has described the variations in the characteristics of two relatively new voltage-reference tubes, one a miniature, the other a subminiature, for severe environmental conditions. The tubes use the well-known reference-tube manufacturing technique involving molybdenum-cathode sputtering and give good stability over long periods of time and at high temperatures. The striking voltages of the tubes are remarkably similar and the repeatability of the striking voltage

for an individual tube is also very good; photo-electric effects have been eliminated. Handly[107] has also determined the running-voltage/temperature characteristics of five types of reliable tube over the temperature range −55°C to +250°C. He concludes that all tube types exhibit a minimum in the characteristics if tested over a wide enough range of temperature. According to Handly, the temperature at which this minimum is obtained is a reliable index of the tube performance. To obtain the best performance in a given case it is necessary to operate the tube at temperatures below that where the minimum occurs. Handly has recorded the bulb temperature rise for each tube type at several different current levels.

The characteristics of three types of subminiature tube, namely XC14, XC15 and NT2, have been examined by the author[108]. The variations in the striking-voltage, extinction-voltage and running-voltage characteristics have been observed. Running-voltage/temperature curves have been recorded and the magnitudes and durations of the initial drifts of the tubes have been determined. Voltage variations during the first 800 hours of life have been noted for one tube of each type when operated continuously at maximum specified current.

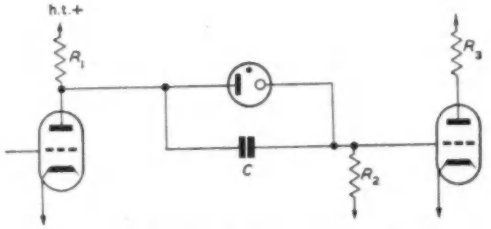

Fig. 10. Glow-discharge tube as coupling element in d.c. amplifier circuit

The development and production of reliable tubes have been discussed by Lynch[109]. Improvements in the types include shock and vibrational fatigue resistance, life stability and performance, shelf-life stability, voltage repeatability and uniformity of mechanical and electrical characteristics. Shock and vibration failures experienced in the initial stages of the work on prototypes were of two kinds: (a) glass envelope failures under impact shock conditions and (b) weld failures under both shock and vibrational fatigue conditions.

Applications

In recent years the demand for glow-discharge voltage-regulator tubes of high stability has risen considerably. It is well-known that such tubes form simple and inexpensive methods of voltage stabilization and are also extensively used in electronic stabilizers of the degenerative type for providing a reference voltage. Glow-discharge tubes are frequently used, too, with linear resistors, or in combination with other non-linear devices, in a bridge circuit[1,110,111] for detecting a change in the input or output voltage of an automatic voltage stabilizer and producing a signal to operate a device for correcting the output voltage to a pre-determined value.

It is frequently desirable in d.c. amplifier circuit design to have circuit elements whose incremental resistance (i.e. the ratio between corresponding voltage and current changes) is different from their d.c. resistance (corresponding to the ratio of total voltage and current). The circuit of Fig. 10 uses a glow-discharge tube as the coupling element which gives a low incremental resistance. The voltage across the tube will remain almost constant. Consequently the tube allows the voltage at the grid of the second valve to be brought to the desired level without any loss of gain due to the interstage network. In fact, the tube acts like an infinitely small resistance with respect to voltage changes while still maintaining a finite d.c. voltage across itself[112-114].

Glow-discharge diodes may be used for stabilizing the anode breakdown voltage of a cold-cathode triode. This technique has led to the developments of stable relaxation oscillators, voltage discriminators or delay circuits and monostable circuits[115]. A recent paper[116] surveys the principles of cold-cathode diodes and triodes, discusses their characteristics and describes typical applications. The diode applications discussed include indicators, monitors, voltage stabilizers, relaxation oscillators, pulse storage and a.f. transmission switches. Simple glow-discharge stabilizing circuits have recently been described by Henry[117] and Degelman[118] and a general article on regulated power supplies by Collins and Smith[119] includes the use of glow-discharge tubes. Vollenweider[120] has discussed tube characteristics and has developed a graphical method for designing stabilizer circuits.

The well-known limitations of glow-discharge tubes have been listed by Hayward *et al.*[121] and they state that the difficulties which arise can be overcome by the use of voltage-reference tubes, in association with a cathode-follower valve. In the circuit suggested, two of these series-connected tubes are shunted by a high-resistance potentiometer, which is tapped to feed the grid of a cathode-follower valve. The output voltage is determined by the setting of the potentiometer and may have any desired value. The maximum load current depends on the choice of valve and the voltages available for it and is no longer dependent on the glow-discharge tube which is operated under optimum conditions to avoid the occurrence of voltage steps. The application of this circuit to provide a low-voltage reference source for use in a valve stabilized power supply unit for 50 to 100V has also been described[121]. Kraus[122] has commented on the arrangement and has discussed alternative valve circuits for obtaining low voltages. His comments have led to further correspondence on the subject[123-125].

The use of glow-discharge tubes as a means of d.c. coupling between different voltage levels is often convenient in electronic circuits. In a circuit described by Court[126] a chain of such valves has been used to transfer direct-voltage variations from an initial reference level of 150V positive to a new reference level of 450V negative with considerably less loss than that which would occur with a resistor chain.

The employment of glow-discharge tubes for stabilization purposes has been mentioned by Luke[127], Braun[128], Thulin[129], Helke and Stenzel[130] and elsewhere[131-141].

The desirable characteristics of glow-discharge tubes vary with the applications; e.g. when used as a voltage stabilizer the tube should present low impedance to ripple frequencies and have good regulation over a large current range. The performance of a simple stabilizer circuit can easily be calculated assuming ideal characteristics, but unless the tube is itself stable and free from drift and erratic voltage jumps the calculation is of little value. With a voltage reference tube the temperature coefficient of running voltage and the initial voltage drift should be small. In addition, the running-voltage/current characteristic should be stable, free from voltage steps and hysteresis, and reproducible to within small limits if the tube is used intermittently. Glow-discharge tubes have been suggested for automatic-telephone switching applica-

tions. For this purpose it is also important to have stable tube characteristics and as pointed out earlier, the usefulness of the tube may be severely limited here unless the impedance presented to a.c. signals over the audio-frequncy range and the tube noise are low. Stability and a reasonably flat running-voltage/current curve are again essential if the tube is used as a coupling element between stages of a d.c. amplifier.

Acknowledgments

Some of the work reported has been carried out in the Department of Electrical Engineering at the University of Sheffield. The author wishes to thank Professor A. L. Cullen for facilities afforded in the laboratories of this Department. He also wishes to acknowledge the kindness of the English Electric Valve Co. Ltd in supplying many special tubes for examination, for financial assistance and for the loan of equipment.

In preparing this article the author has made use of some of the information and diagrams in the papers listed as items 6 and 7 under the section References. These two papers were first published by The Institution of Electrical Engineers as Paper No. 2394R and Monograph No. 321R respectively and have been republished in the Proceedings of the Institution. The curve with the broken line on Fig. 2 has been reproduced from reference 9 by permission of Philips Electrical Ltd. Fig. 5 is reproduced from reference 31 by kind permission of the Editor of British Journal of Applied Physics, Figs. 6 and 7 are reproduced from references 41 and 44 respectively by kind permission of The Institute of Radio Engineers, Inc. and Fig. 9 is reproduced from reference 62 by kind permission of the Editor of the Journal of Applied Physics.

The author is most grateful to Dr. C. P. Marsden of the National Bureau of Standards, Washington for giving him permission to reproduce material from an unpublished paper on metal-ceramic seals and for his valuable comments on the section in the article dealing with this topic.

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The Telecommunications Engineering Establishment

The Ministry of Aviation's new Telecommunications Engineering Establishment at Gatwick was formally opened at the beginning of last month. This Establishment is responsible for field installation work of Ministry-operated civil aviation telecommunications equipment, and the manufacture, overhaul, testing and repair of telecommunications systems and ancillary equipment. In this field it also undertakes investigations, trials, surveys, design and other engineering work.

The Telecommunications Engineering Establishment was formed on 1 May, 1959. Shortly afterwards it was decided to house the Establishment in new premises at Gatwick. Sections of the telecommunications staff moved in to the partially completed buildings in April last, and some 150 staff have now been transferred.

Prior to the war there was a civil signals organization in the Air Ministry. In 1946, the year after the setting up of the Ministry of Civil Aviation, a small unit, named the Installation, Test and Repair Unit, was formed at Mitcham, Surrey, and later moved to Yeading, Middlesex. Among its many duties was the search of military depots for salvageable equipment and stores. In fact the first ten years after the war saw civil air operations in this country carried out almost entirely on surplus war material in so far as ground based telecommunications equipment was concerned. However, this period of enforced improvisation did have certain advantages. It allowed time for a good deal of thought and discussion to take place at the International Civil Aviation Organization and for research and development within the industry and Government organizations to determine the systems and standards required to meet civil aviation needs.

A g.c.a. Maintenance and Inspection Unit was formed in 1947 at Blackbushe Airport. This unit rebuilt the g.c.a. equipments at intervals and exchanged them regularly at civil airports. From this small unit came redesign proposals resulting in the precision approach radar system which is constructed at the Establishment and which are used at civil airports. To this unit was added a section dealing with longer range radars. This section is now involved in the integration and system engineering of the major a.t.c. centres.

The new and comprehensive Establishment, which has absorbed these smaller units, is concerned with the field engineering of safety services. It is responsible for installation programmes and the major overhaul of equipment to prolong its usable life and sustain its performance to acceptable standards. It constructs small specialized quantities of equipment, and produces models and prototypes. It carries out on behalf of the Ministry's Tels. Engineering Headquarters detailed investigations, measurements and trials, and initiates detailed proposals towards the subsequent design specification of equipment. Similarly it initiates necessary alterations to maintenance procedures and routines at working stations so as to secure maximum use and life from the equipments. It is also concerned with system engineering where diverse equipments have to be integrated to meet the working requirements of such user organizations as Air Traffic Control, Aviation Police, Aviation Fire Services and Aerodrome Management.

These new premises provide a base headquarters at which and from which the staff will in future conduct their work. The buildings are simple and functional, and are designed so as to be capable of expansion as the scale of activity inevitably expands.

Britain's Radar Defences

In the immediate post-war years it became a matter of urgency to re-equip the Royal Air Force with new ground radar stations in order to modernize Britain's air defences. The overall responsibility for the implementing of this project was placed with Marconi's Wireless Telegraph Co. Ltd. Concealed in the code names 'VAST' and 'ROTOR', the task was carried out under conditions of absolute secrecy; only now, after ten years have elapsed, has it become possible to divulge some information on the circumstances under which the new chain of stations was built

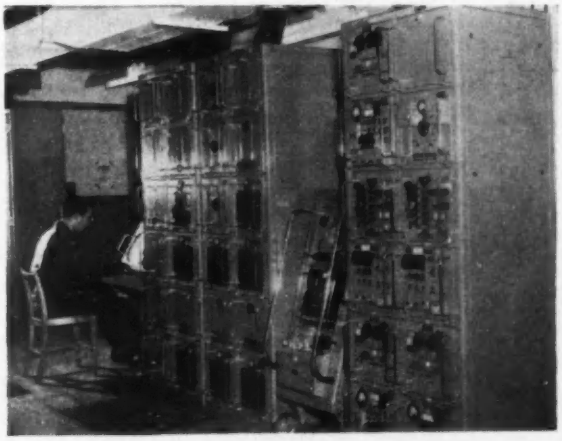
In 1949 Marconi's were entrusted with the task of modernizing a number of Air Ministry C.H. and G.C.I. stations as a matter of urgency. At the same time the Ministry put in hand a project which involved the design and construction of an entirely new radar chain employing the latest techniques and housed deep underground in concrete structures; this was to be backed by a large number of mobile radar convoys; the latter was concealed in the code name VAST and the former became ROTOR.

In both these projects Marconi's were assigned the responsibility for the handling of the design of the radar equipment, the station planning, the installation and the testing, the whole to be carried out in the closest co-operation with the Air Ministry. The ROTOR stations were to be of three types—namely G.C.I., C.E.W. and C.H.E.L.

With the task of their design completed in record time the installation programme began in 1951, and while the number of stations involved still cannot be divulged it can be said that at one period up to 20 sites were in process of installation simultaneously.

Further contracts followed as the magnitude of the project grew, with additional stations to give further cover to the approaches to the British Isles. Some of these, built on remote Scottish islands, posed considerable problems of transportation and access, but the whole of the VAST-ROTOR programme was completed in accordance with operational requirements.

Part of a typical radar installation



A Constant Temperature Transistor Enclosure

By M. W. Rignall*

A constant temperature enclosure capable of housing twelve OC201 sized transistors is described. It consists of an aluminium block using an OC29 as the heating element and a thermistor as the temperature sensing element. The temperature can be held to any given value in the range 35°C to 55°C with a constancy of better than 0·25°C. Operation in an ambient temperature of −40°C should be possible if a long warm-up time is tolerable.

(Voir page 474 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 482)

WITH the inherent temperature variations of many transistor parameters, the construction of high stability circuits over a wide range of operating temperatures calls for a considerable amount of temperature compensation. This may be included in the form of positive and negative coefficient thermistors or by making relatively temperature insensitive circuits.

The requirement existed for a frequency meter in the audio band capable of operating over a temperature range of −10°C to +50°C with a drift of less than ±0·25 per cent.

It was found that no compensating circuits could bring the drift within these limits, since the final stage consisted of a three stage d.c. amplifier to feed a pen recorder requiring 150mW.

To achieve the necessary stability the only solution was to maintain the temperature of the circuits constant to within narrow limits. If a limit of ±0·25°C was applied, the circuits could be simplified considerably.

Construction

To obtain the necessary equality of temperature between the various circuit elements, an aluminium block containing the transistors, heating and sensing elements, embedded in silicone grease to give good thermal contact is used.

Twelve OC201 sized transistors can be inserted in a block 2¼in × 1in × ⅜in. The block is in turn surrounded by small component boards for the less critical circuit components. The complete assembly is then placed in a small draught proof box lagged by foam plastic (see Fig. 1).

The heating element must raise the aluminium block to the required operating temperature from the lowest ambient in a reasonable time. With no heat losses the required power for a given mass of block and a known temperature rise is easily found. In practice due to losses through the lagging (which is a function of both time and temperature difference) extra power is required. If in practice the lagging is assumed 70 per cent efficient adequate allowance can be made for the losses.

Due to the excellent thermal contact available, a power transistor makes an ideal heating element. The available dissipation of a power transistor is given by:

$$W = \frac{T_j - T_{mb}}{\Theta}$$

where W = maximum dissipation

T_j = maximum junction temperature

T_{mb} = mounting base or block temperature

Θ = internal thermal resistance (°C/W).

with a block temperature of 55°C, using an OC29 as a heater, the available heater power is:

$$W = \frac{90 - 55}{1{\cdot}5} = 23{\cdot}3\text{W}.$$

This represents the maximum power available for the duration of the warm up time.

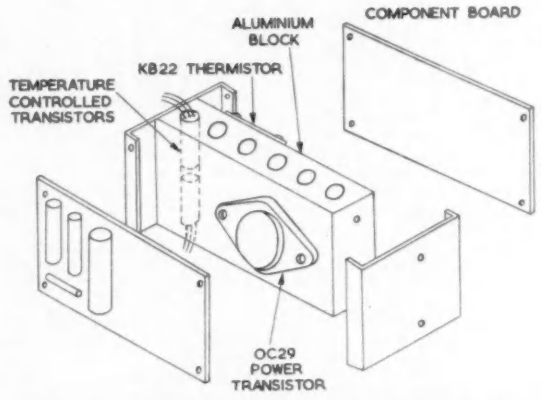


Fig. 1. Constant temperature block exploded view (lagging not shown)

The power requirement to heat the block of aluminium to a given operating temperature in a given time from the minimum ambient is given by:

$$W = \frac{m.\,s.\,(t_{op} - t_{amb})\,J}{T.\,60.\,n.}$$

where m = Mass of block

s = Specific heat of block

t_{op} = Block operating temperature

t_{amb} = Minimum ambient temperature

T = Warm up time

n = Efficiency of lagging (70 per cent)

J = 4·18 joules/calorie.

The sensing element used is a KB22 (S.T.C.) thermistor, once again because of the excellent thermal contact afforded by the plate type of thermistor.

In Fig. 1 the relative positions of heater and thermistor are shown. They should ideally be positioned as closely as possible to avoid overshoot on the block temperature due to transit time through the block (see Fig. 3).

Circuit

A simple bridge is used, since the supply voltage may in practice not be stabilized, and the bridge gives good isolation from supply variations. The circuit described will maintain the temperature of the block to ±0·15°C

* *Marconi's Wireless Telegraph Co. Ltd.*

for a voltage change of 10V to 14V, the warm up time being dependent on applied voltage.

The unbalance current of the bridge is used to turn on the OC29 to a pre-set power level. The circuit used is shown in Fig. 2.

The bridge is formed by R_5, R_3, R_1 and $(RV_1 + R_2)$. R_1 being the variable.

When the block is cold the resistance of R_1 is high, causing the base to be positive with respect to the emitter and bottoming VT_1. This in turn bottoms VT_2, the maximum collector current of VT_2 being the base drive current to VT_3, thus determining the collector dissipation.

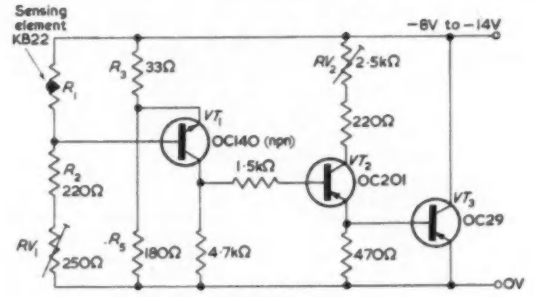


Fig. 2. Control circuit diagram

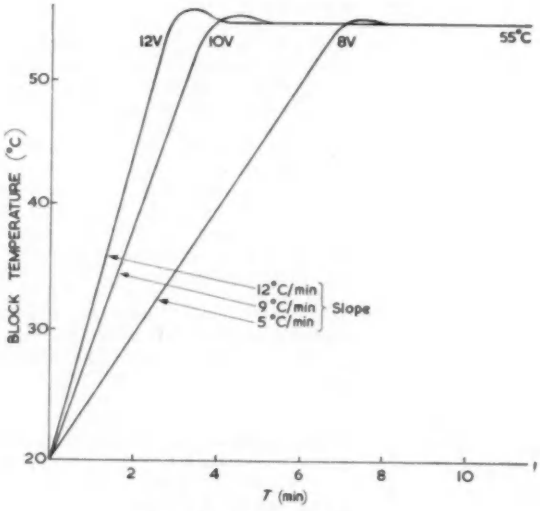


Fig. 3. Block warm up time

Power dissipated in VT_3 heats the block, causing R_1 to decrease until VT_1 comes out of bottoming thus reducing the power in VT_3. Finally with a further decrease in R_1, VT_1 cuts off. After the overshoot of block temperature (Fig. 3), a small residual current flows in VT_3 to replace heat loss through lagging. This current increases inversely with ambient temperature and amounts to approximately 230mA at 0°C to 50mA at 50°C at 12V input. Since the block temperature is always aiming at the instantaneous junction temperature (90°C for 55°C block) the rate of temperature increase is nearly constant with time, from Fig. 3 this is found to be approximately 12°C/min.

The unit is set up at any required temperature by adjustment of RV_1 and observing a thermometer placed in one of the drillings in the block. RV_2 is set to give 1·4A collector current in VT_3 at 12V, which avoids over-dissipation at 14V input. If a 12V stabilized supply was used this current could be increased to 1·9A with a resulting decrease of warm up time.

Conclusion

With approximately 12in³ and 2 to 3W from a 10 to 14V supply, eight transistors and some of their associated components can be held to a given temperature in the range 35°C to 55°C to a constancy of better than 0·25°C, enabling otherwise impractical circuits to be used over a wide range of ambient temperatures.

Operation to −40°C should be possible if a long warm up time is tolerable.

Specialized Valves and Capacitors

The start of a further expansion programme for the production and marketing of new and present types of valves and capacitors was announced recently by Standard Telephones and Cables Ltd. Until now a large proportion of the products of these two divisions have been 'in-fed' into other Divisions of the Company for equipment manufacture. While this will, of course, continue, a greater emphasis will, in future, be placed on external sales both in this country and abroad.

Both the Valve and Capacitor Divisions are housed in the modern factory which has been erected at Paignton in Devon.

In the Valve Division plant the principal products are valves for use in telecommunication systems such as microwave radio links and transoceanic telephone cables, and in the industrial applications of radio frequency heating. The wide range of valves includes rectifiers, thyratrons, low-power 3-, 4- and 5-electrode valves, high power transmitter valves, valves for industrial heating, microwave valves and pulse modulators, cold cathode triggers, counters and indicators, and many special devices such as bolometers, vacuum capacitors, manometers and thermal delay switches.

Expansion is envisaged in the production and application of almost all of these types of valve.

Capacitors, like valves, have been key products of STC for many years and were formerly made mainly at North Woolwich, London, with a satellite plant at Treforest in Wales. The success of the Valve Division operations at Paignton, coupled with the Company's desire to avoid over-concentration in the London area, led to the building of a second factory on the Paignton site for the manufacture of capacitors.

The final moves in this centralization process have now been completed with the recent transfer of the department which makes the special capacitors for use in undersea telephone repeaters; this department was previously integrated with the main submerged repeater manufacturing plant at Woolwich. The Treforest factory retains its position as the production unit for power capacitors.

Many of the fundamental patents upon which modern paper, mica and electrolytic capacitors are based were registered by the Company.

The present range includes coated foil, mica, oil-filled paper and tantalum electrolytic capacitors, radio interference suppression units for aircraft and marine use, and capacitors for power factor improvement.

The latest oil-impregnated, oil-filled paper capacitors have sintered glass seals and are suitable for operation in high ambient temperatures. A new range of robust, solid electrolyte tantalum capacitors has been introduced recently which promises to have many interesting applications, including some in the field of guided missiles. There have been important advances in coated foil capacitors, which are now in production.

The factories are designed to allow for expansion on the same site; they are fully air-conditioned and have special 'ultra clean' areas for the manufacture of submerged repeater components. The total floor area is 250 000ft² at present, an unusually high proportion of this space being devoted to research and development work. A 60 000ft² extension to the capacitor factory has now been started.

Short News Items

The Summer Meeting of the Electronics and Communications Section of the Institution of Electrical Engineers was held at Cologne on 4 to 7 May. The main visit during the meeting was to the Headquarters of the British Army of the Rhine at München Gladbach. After an address of welcome by Brig. E. J. C. Harrison, O.B.E., a mobile demonstration was given of cable laying and of the use of helicopters and armoured vehicles for communication purposes. Some 25 exhibits of electronic and communication equipment were provided by the Royal Regiment of Artillery, the Corps of Royal Engineers, the Royal Corps of Signals, the Army Air Corps, the Royal Army Medical Corps and the Corps of Royal Electrical and Mechanical Engineers. Visits were also paid to the West German Post Office Station at Dusseldorf and to the Westdeuscher Rundfunk's short wave transmitting station at Jülich.

Sir Bernard Lovell, O.B.E., F.R.S., Professor of Radio Astronomy at the University of Manchester and Director of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, has accepted the appointment of Scientific Adviser to the British Space Development Company. He will assist the company's technical committee which is engaged in detailed investigations into ways and means of launching a British space programme for communication satellites in the near future.

Copies of the Annual Report of the Council of the Institution of Electrical Engineers for Session 1960/61 and of the Accounts for the year ended 31 December 1960, are now available and can now be obtained by members of the Institution on application to the Secretary.

The British Electrical and Allied Manufacturers' Association has recently established two new Sections within its organization. The first of these is an Industrial Electronic Equipment Section which in addition to day-to-day work relating to technical matters, standardization, exports and statistics, will also provide a means of closer discussions with other associations and help towards the wider examination of general policy questions affecting the industrial electronics industry as a whole. Mr. W. Gregson, of Ferranti Ltd, has been elected chairman, and Mr. R. J. F. Howard, of Metal Industries Ltd, is vice-chairman. Mr. A. Newton has been appointed secretary. The Second Section is the Nuclear Reactor Section which has been formed to cover nuclear reactors for electrical power applications.

Dr. E. Eastwood, Director of Research at the Marconi Research and Development Laboratories at Great Baddow, will be presented with the Wakefield Gold Medal by the Royal Aeronautical Society at its Wilbur Wright Memorial Luncheon on 12 September. The award is in recognition of his contributions towards safety in the air by the development of air traffic control and navigational aids.

Recommendations on "The Future of Television Broadcasting in Great Britain" have been submitted by the British Institution of Radio Engineers to the Pilkington Committee on Broadcasting. The Technical and Television Group Committee of the Institution have carried out a survey of the engineering considerations involved in sound and television broadcasting, such as wired television, television standards and colour television and have made a number of recommendations. These include the setting up of a National Communications Authority to take decisions on matters relating to standards, frequency allocation, etc. The recommendations have been published in booklet form and copies (price 5s) may be obtained from the secretary of the Institution, 9 Bedford Square, London, W.C.1.

Developments in satellite communications and the questions arising have now been discussed at a meeting of representatives of the Post Office and of the Society of British Aircraft Constructors, the British Constructional Steelwork Association, the Electronic Engineering Association, the British Electronic and Allied Manufacturers' Association, the Radio Industry Council, and the Telecommunication Engineering and Manufacturing Association. In the discussion there was a full exchange of views on the many aspects of the subject, including the machinery that might best be adopted to foster full co-operation between the Post Office and British industry in this rapidly developing field.

The evaluation of π was recently undertaken as a machine reliability test on an EMIDEC 1100 Computer based on a programme prepared by N. D. Robinson of EMI Electronics Ltd, Hayes. The complete operation occupied 13 hours of computing time and evaluated π to 10 880 decimal places.

A control console for single-sideband transmitting and receiving equipment has recently been supplied to the Admiralty Surface Weapons Establishment for installation at a Royal Naval Air Station, to provide ground to air communication. Up to 12 transmitters and 12 receivers may be remotely controlled from the console; the switching and audio connexions being established over Post Office lines some 10 miles in length. The voice transmission circuits are equipped with automatic gain control (VOGAD) amplifiers to ensure full modulation of the transmitters under all conditions of use, and facilities are provided for speech clipping to be switched into circuit as an aid to long-range voice communication. The design and production of the single-sideband control console were undertaken by the Electronics Division of The General Electric Co. Ltd, to the specification of the Admiralty Surface Weapons Establishment, Portsmouth.

Cawkell Research & Electronics Ltd of Southall, Middlesex, have recently supplied a complete installation of electronic equipment for measuring the rapidly fluctuating quantities associated with the operation of high speed machine tools. This installation employs Remscopes (Storage oscilloscopes) for the display of the resulting waveforms so that photography is unnecessary. The complete equipment consists of resistance strain gauges and their associated amplifiers for measurement of the strains occurring in the tool, and piezo-electric accelerometers for the measurement of the accelerations during the cutting operation and three Remscopes to record the voltages derived from these transducers. A fourth Remscope is so arranged that it can take any part of one of the received waveforms and display it on an expanded time-base for detailed observation.

The report of the first interfirm comparison among members of the Scientific Instrument Manufacturers' Association of Great Britain, 20 Queen Anne Street, W.1, has been issued to the 24 firms taking part. The comparison was conducted for S.I.M.A., by the Centre for Interfirm Comparison, which is a neutral expert organization set up by the British Institute of Management and the British Productivity Council to undertake this work on behalf of any group of firms or trade organization which may wish to undertake comparisons.

The BBC has placed an order with Marconi's Wireless Telegraph Co. Ltd for two more 100kW twin-channel short-wave transmitters. This is a further stage in the work of modernizing and re-equipping the short-wave transmitting stations of its External Services where most of the installations have been in operation since the early days of the last war. These new transmitters, together with two more

of the same type already on order, are for the Daventry station. They will be similar to those recently installed at the BBC's short-wave station at Rampisham, Dorset.

The Electronic Engineering Association has announced that the 1961 Award Scheme for Technical Writing is to be revised. It is now proposed that the number of awards will be increased from six to eight and the premiums from 25 guineas to 30 guineas. The awards will be made for wholly technical articles as well as articles of commercial and interpretative merit. The Electronic Valve and Semiconductor Manufacturers' Association (VASCA) and the Scientific Instrument Manufacturers Association (SIMCA) have been invited to join as additional sponsors.

The Data Processing Technical Committee of the Electronic Engineering Association has recently produced a list of available shaft digitizers and mechanical low level switches in order to make available information on these components to members of the Association. It is intended to review the list periodically and bring it up to date, not only in respect of current types but also those under development. To this end the Association would be pleased to make available the list to manufacturers and users interested in co-operating in this task. Enquiries for copies of the list should be addressed to The Technical Secretary, E.E.A. 11 Green Street, Mayfair, London, W.1.

One of the activities planned in connexion with the Commonwealth Technical Training Week was the interchange of trainees between firms in the United Kingdom and those in Commonwealth countries. The General Electric Co. Ltd is participating in this exchange scheme, and is sending a student apprentice from the parent company to receive a year's experience with the British General Electric Company Pty. Ltd of Australia. In return the G.E.C. is receiving a trainee from its Australian company.

A Residential Symposium on Network Theory is to be held by the Department of Electrical and Control Engineering of The College of Aeronautics, Cranfield, on 18 to 22 September 1961. Details are obtainable from S. R. Deards. Department of Electrical and Control Engineering, The College of Aeronautics, Cranfield, Bletchley, Bucks.

The Television Society has awarded the following Premiums, for outstanding papers read before the London meetings in 1959-60. The E.M.I. Premium to Dr. Rolf Moller (Fernseh GmbH) for his paper on Television in Germany. The Electronic Engineering Premium to Mr. B. Eastwood (A.E.I. Ltd) for his paper on Deflexion Techniques for 110° Pictures Tubes. The Mervyn Premium to Mr. S. T. Palmer, (G.E.C.) for his paper on Television Receiver Production: Modern Manufacturing Techniques and Maintenance Quality. The Wireless World Premium to Mr. A. J. Garratt (International Scientific Research Exhibitions Ltd) for his paper on Science on Television. The Mullard Premium to Mr. R. N. Jackson (Mullard Research Laboratories) for his paper on Single-Gun v. Three-Gun Tubes: Their Influence on Colour Receiver Design.

The P & O Liner 'Canberra' which has recently sailed on her maiden voyage to Australia has been equipped with radio and television facilities similar to those installed in the company's liner 'Oriana'. The system, manufactured and installed by Marconi's Wireless Telegraph Co. Ltd, will enable television broadcasts to be received anywhere in the world using the British 405 line system, the 625 line system used in Australia and the greater part of Europe and the 525 line system as in the United States, Canada, Japan and in some South American countries. A comprehensive broadcasting system designed and supplied by Tannoy Marine Ltd has also been installed in this vessel. Two programmes, either radio or prerecorded news, are available to passengers, officers and crew.

The Hon. J. R. C. Geddes (Elliott Automation Ltd) has been elected vice-chairman of the Publicity Committee of the Electronic Engineering Association, in succession to Mr. R. P. Raikes, D.S.O., (Marconi's Wireless Telegraph Co. Ltd). New members of the committee are Mr. A. G. Coaten (International Computers and Tabulators Ltd) and Mr. M. W. Figgis (IBM United Kingdom Ltd).

Radio and television apparatus, telephone and telegraph equipment and scientific instruments are included in a comprehensive analysis of U.K. exports of electrical and allied engineering equipment over the past three years 1958-60 which has just been published by the British Electrical and Allied Manufacturers' Association. The analysis shows the values of exports from this country to 85 different destinations under different product headings in the electrical field and also includes summary details of exports to the Commonwealth and European countries separately. Entitled "Territorial Analysis of British Exports of Electrical and Allied Machinery and Apparatus". This analysis is now obtainable from the BEAMA Information Services, 36 Kingsway, London, W.C.2, price 7s 6d per copy.

The Joint Radio Committee of the Nationalized Fuel and Power Industries has prepared a Basic Specification for Electronic Telecontrol Equipment which sets out the common requirements of the Coal, Electricity and Gas Industries in regard to the remote indication and control of plant. In this way it is hoped to rationalize the production of suitable equipment and avoid the necessity of designing equipments on an individual basis for specific applications. The specification provides information on the minimum facilities required and guidance on the the techniques preferred, e.g. the use of items such as cold cathode tubes, transistors, magnetic cores etc, rather than electro-magnetic relays and hot cathode valves, but it intentionally avoids laying down rigidly the exact manner in which any facility should be provided. Copies of the Basic Specification may be obtained from Mr. G. D. Turton, Secretary, Joint Radio Committee of the Nationalised Fuel and Power Industries, c/o Central Electricity Generating Board, Bankside House, Sumner Street, S.E.1.

Mr. John Clark (Plessey Company Ltd) has been elected vice-chairman of the Radio and Electronic Component Manufacturers' Federation, in succession to Dr. G. A. V. Sowter (Telcon Metals Ltd) who is now chairman.

The Department of Scientific and Industrial Research has appointed Dr. Charles Manders to the new post of Scientific Attaché to the British Embassy in Tokyo to advise the British Ambassador on scientific matters and to report on Japanese scientific and technical development in the civil field. The D.S.I.R. has also appointed Mr. W. Drury to a similar post at the British Embassy in Stockholm.

The Department of Scientific and Industrial Research is to contribute over three quarters of a million pounds towards a new nuclear physics research centre at Oxford University This is the largest single grant ever made by the Department and will provide a particle accelerator of novel design with which it is planned to carry out an extended programme of long-term research on nuclear structure. In addition the National Institute for Research in Nuclear Science will carry out the design of part of the accelerator at a cost to the Institute of £200 000, which, with further aid from the University Grants Committee, brings the total government support for the project to approximately £1M.

A Symposium on Photomultiplier Tube Applications will be held at EMI House, Manchester Square, W.1, from 13 to 15 September. The aim of the symposium is to exchange information on the application of photomultiplier tubes in a wide variety of scientific and industrial fields, and to encourage discussion on the ways in which improvements can be made and new fields opened. Speakers from the United Kingdom and abroad will include experts in various fields of p.m. tube application, such as nuclear energy, spectroscopy, astronomy, upper atmosphere research, television and printing. A nominal fee will be charged, to in-

clude a copy of the proceedings which will be sent to registrants shortly after the symposium. Further information and application forms can be obtained from EMI, Electronics Valve Division, Hayes, Middlesex.

Electronic control of machine tools was the subject of three symposia organized by the Electronic Apparatus Division of Associated Electrical Industries Limited, and held during May at New Parks, Leicester. Lectures were given by the company on a wide range of topics and demonstrations were arranged of staircase milling and tracing, including the "Numeritool" system developed to effect continuous, co-ordinated control of machine-tool movements from digital recordings on magnetic tape.

Semiconductors Ltd, a joint subsidiary of the Plessey Company and the Philco Corporation have announced the availability of a new range of their micro-alloy diffused transistor (m.a.d.t.) for application for v.h.f. and television receivers up to frequencies of 200Mc/s. These will be followed by a 150mW micro-alloy diffused switching transistor and a coaxial m.a.d.t. having an f_{max} of 3 000Mc/s and and a gain of 100dB at 1 000Mc/s.

Marconi's Wireless Telegraph Company Limited has now acquired the Wembley factory of EMI Electronics Ltd as a staffed and equipped working entity. The factory is approximately 85 000ft² and at present has a staff of between 400 and 500.

The 1961 Dinner of the British Institution of Radio Engineers was held in London on 8 June. The toast of the Institution was proposed by Sir Howard Florey (President of the Royal Society) and the response was made by the Earl Mountbatten of Burma as President of the Institution. The High Commissioner of Canada, the Hon. George A. Drew replied on behalf of the guests.

International Computers and Tabulators Ltd have recently received orders from South Africa for six of their new magnetic tape computers, the I.C.T. type 1301. The total value of the orders is £600 000. Sixteen smaller I.C.T. computers have already been supplied to South African users. The South African Railways have ordered three of the new computers; the other orders, all for single machines, are from the Johannesburg City Council, Caltex (Africa) Ltd, and Stewarts & Lloyds of South Africa Ltd.

The new Post Office cable ship 'Alert' has recently left London to lay cable in the St. Lawrence River, Canada, as part of CANTAT, the U.K.-Canada transatlantic telephone cable, the first part of which was laid last month by H.M.T.S. 'Monarch'. Among the navigational aids carried by the 'Alert' is a Decca Navigator and a True Motion Radar. A full range of radio communications equipment, supplied and installed by the Marconi International Marine Communication Co. Ltd., provides adequate transmission and reception facilities for reliable communication by either telegraphy or telephony.

Hong Kong's new airport passenger terminal will be equipped with closed-circuit television, supplementing the public address system, when the building goes into operation early in 1962. Instead of announcements being repeated over a public address system, the screens will show an announcer, followed by the text of his statement. Twenty receivers will be installed throughout the air terminal. It is expected that the installation of the system will considerably reduce the noise within the building itself if the number of announcements becomes excessive. The closed circuit television equipment is being supplied by Pye Industrial Television Ltd and the public address equipment by Westrex Ltd.

Barclays Bank have developed an off-line paper tape checking equipment to be employed at their first Computer Centre which is due to commence operations shortly. The equipment carries out a parity check on each character and a format test on each information block. Incoming data tapes (received over line) are checked prior to processing thus enabling any errors to be corrected before the tapes are fed to the computer. The result is a significant increase in overall efficiency. The final engineering and construction of the equipment has been carried out by Recording Designs Limited of Walton-on-Thames.

The Solartron Electronic Group Limited are now able to release details of a contract recently awarded to them by the Ministry of Aviation for the supply of equipment for high speed processing of digital radar information and data handling equipment to the Royal Aircraft Establishment at Aberporth. The equipment, in effect, creates a Radar picture so that the target (missile) is observed, during its approach to its destination, at all stages of progress, during which time the 'control brain' causes all other associated equipment to follow the target (missile). The polar co-ordinates of two targets are provided in digital form by the outputs of two AN/FPS 16 radar installations. This data is fed over landlines to a control centre where it is converted to cartesian co-ordinates, and a number of parallax corrections are made, corresponding to the location on site of other slave equipment, such as telemetry aerials, photographic tracking gear etc. A feature of the computing equipment, which basically consists of 6 Solartron Minimal Computers, is the extremely high rate of computation, the requirement being for 2 Polar/Cartesian conversions, 14 Parallax corrections, and 4 Cartesian/Polar conversions, performed every 50 milliseconds, all to 1 part in 10^6 accuracy.

Open Days were held on 9 to 10 June at Farnborough, Hants, by the Royal Aircraft Establishment when exhibits were on display covering the activities of the various Departments of the Establishment. Considerable emphasis was given by the Guided Weapons Department to their research and development of satellite launching vehicles and satellites for space research and communications. Among the displays in the Radio Department was a system of world-wide navigation in the v.l.f. range of 3-30kc/s.

The Atomic Weapons Research Establishment, Aldermaston, have developed 10kV, 10μF capacitor units, which enable currents of several hundred thousand to one million amperes to be realized with a minimum of energy storage (5 000 joules) and having a very small rise time. An important feature of the devices is the low-inductance connexions they employ, consisting of metal foil strips separated by extremely thin insulating material (·006in) for 10kV; ·06in for 100kV). In a test, one unit having a capacitance of 10μF and a working voltage of 10kV, was charged and discharged through a low-inductance switch 10 000 times without a break-down, the ringing frequency of the discharge being 1Mc/s and the current 700 000A. The U.K. Atomic Energy Authority have granted licences for the manufacture of these capacitors to several companies in the United Kingdom. Further information is available from the Patents Licensing Officer, U.K. Atomic Energy Authority, 11 Charles II Street, London, S.W.1.

Marconi's Wireless Telegraph Co. Ltd and the English Electric Valve Co. Ltd, associated companies within the English Electric Group, have been accorded the award of the National Academy of Television Arts and Sciences with the Radio Corporation of America. The award is in recognition of the independent development of the 4½in image orthicon camera and pick-up tube.

The death is announced with regret of Mr. Geoffrey Parr at his home in London on 30 May. Mr. Parr was Managing Editor of ELECTRONIC ENGINEERING from 1941 until 1949 when he left to become Technical Director of Chapman & Hall Ltd, which position he held until his death. He was one of the original members of the Television Society which he joined as a Fellow in 1943 and for a number of years has been the Editor of the Journal of the Television Society.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

Measuring the Heart Rate of an Active Athlete

DEAR SIR,—With reference to the article by D. W. Hoare and J. M. Ivison in January 1961, I have found this article very interesting as it is certainly a problem which concerns many physiologists. I have been interested in the measurement of heart rate on miners who work in very hot and humid conditions, and have therefore made a careful study of the various methods used. In all the applications I have seen or read about, the physiologist always tends to blame any interference on muscle noise. In my opinion, most of it is due to faulty contact between the electrodes and the skin. After testing many types of electrodes and positions, I have come to the conclusion that the most important step is to prevent a direct contact between the electrodes and the skin, especially when the skin perspires.

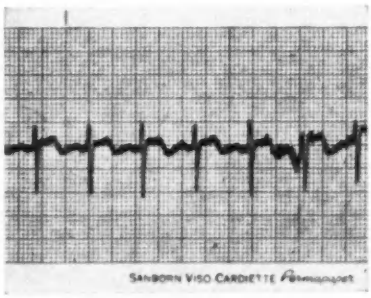


Fig. 1. Pen recording of heart rate

I would therefore like to suggest to the authors that they try impregnated paper in place of the electrode jelly. This I have found to be far more satisfactory.

There are two types of electrodes which have given me reliable results from subjects working in an atmosphere with an air temperature of 98°F and 96 per cent humidity. The results were taken over a period of three hours with the subject perspiring freely the whole time. Fig. 1 is a record taken after two hours from a subject who stopped working and took a brick in each of his hands and swung his arms around as fast as he could, in windmill fashion. This test introduces the maximum amount of muscle movement across the chest.

The first electrodes consist of a non-corrosive metal gauze, about two inches square, wrapped in cotton gauze to form a pad which is saturated with electrode jelly. Two of these are strapped to the chest. The disadvantages are that they occupy a large surface area of the body and they are messy to use.

The second type is similar to that described by L. J. Ryan in *Science*, page 564, 19 October 1959, or more recently in the "Proceedings of the Third International Conference on Medical Electronics." The electrode is made of thin polythene in the shape of a hat with the top and bottom open. The base is stuck to the skin with a rubber based cement, then the hat is filled with e.c.g. jelly from the top. A metal cap, which has a centre pin to make contact with the jelly and to which the lead is attached, is then clipped on the top. The electrode will remain securely in position, even if the subject is perspiring, until it is removed with a solvent such as acetone.

There is one question I should like to ask the authors. A two channel system is used with a common electrode *A* on the chest for both channels. Any interference at this electrode will give a co-incidence pulse in each channel and therefore result in a false count. Since this is the electrode which is likely to cause most of the trouble, is there any point in having these two channels?

Yours faithfully,

A. R. ATKINS,

Chamber of Mines,
Johannesburg,
South Africa.

The Authors' Reply:—

DEAR SIR,—We thank Mr. Atkins for his comments on our article.

Contact between the electrodes and the skin did cause considerable trouble in the early stages of development of the equipment, but the effect of variations of 'source' resistance was minimized by the use of high input impedance emitter-follower first stages for the amplifiers.

We note Mr. Atkins' remarks regarding types and positions of the electrodes; since writing the article we have found a gauze pad, soaked with electrode jelly, used with the electrodes gave some improvement in performance. Regarding the positioning of the electrodes, Geddes, Partridge and Hoff[1] have successfully used small electrodes, jellied and taped over the xiphoid and manubrium process. It is our intention to do further work on the electrode problem and we thank Mr. Atkins for his suggestions.

We agree that any interference at the common chest electrode *A* on our equipment will give a coincident signal on both channels, but our tests showed that the double channel system gave a worthwhile improvement over a single channel, indicating that the common electrode was by no means entirely responsible for the interference.

Yours faithfully,

J. M. IVISON, D. W. HOARE,

College of Technology,
Loughborough,
Leicestershire.

REFERENCE

1. GEDDES, L. A., PARTRIDGE, M., HOFF, H. E. An EKG Lead for Exercising Subjects. *J. App. Physiol. 15*, 311 (1960).

Correction

Mr. J. S. Bell the author of the letter "The Development of the h-Parameter Formulae Using Matrices" published in the June issue regrets that two errors have occurred and equations 11 and 12 should read as follows:—

$$= \frac{h_{11}' - h_{12}'\, h_{21}'}{h_{22}' + G_L} \quad \ldots\ldots\ldots (11)$$

$$= \frac{h_{11}' + R_S}{|h'| + h_{22}'} \quad \ldots\ldots\ldots\ldots (12)$$

PUBLICATIONS RECEIVED

SILICONES IN ELECTRONICS is a 24-page booklet describing the main types of silicone products of use to the electronic industry and quotes from actual practice examples of successful applications of Midland Silicones' products by many companies. The booklet is divided into three main sections: the first deals with encapsulating, impregnating, filling and coating materials; the second with fabricated insulatin, and structural components; and the third with production aids. Copies of the booklet are available from Midland Silicones Ltd, 68 Knightsbridge, London, S.W.1.

MAN MUST COUNT is the title of a leaflet describing the features of a number of new instruments by the Trumeter Co. Ltd. This publication is available to all who enquire to the Company at the following address: Milltown Street, Radcliffe, Lancs.

THE DESIGN AND PRODUCTION OF PRINTED CIRCUITS is the title of a brochure produced as a guide to all engaged in the manufacture of equipment using printed circuits and for buyers of this component, by Technograph Electronic Products Ltd. Copies of the brochure are available on request to the Company at Eros House, 29-31 Lower Regent Street, London, S.W.1.

A GUIDE TO THE FUTURE REQUIREMENTS OF PAPER TAPE READERS AND PUNCHES FOR USE WITH DATA PROCESSING EQUIPMENT is a guide produced by The Electronic Engineering Association which represents the future thinking of the data processing equipment manufacturers on the basic requirements for paper tape reader and punches which the Association are particularly interested in bringing to the attention of manufacturers of this type of equipment. Copies of the guide can be obtained from the Technical Secretary at 11 Green Street, Mayfair, London, W.1.

BBC ENGINEERING DIVISION MONOGRAPH Number 35 entitled "Tables of Horizontal Radiation Patterns of Dipoles Mounted on Cylinders" by P. Knight and R. E. Davies has recently been published. This is one of a series published by the BBC and about six are produced every year, each dealing with a technical subject within the field of television and sound broadcasting. Individual copies cost 5s. and are available from BBC Publications, 35 Marylebone High Street, London, W.1.

BOOK REVIEWS

Transistors: Principles, Design and Applications

By W. W. Gärtner. 675 pp. 322 figs. Medium 8vo. D. van Nostrand Co. Inc. 1960. Price 94s.

SINCE the invention of the transistor there have been a number of books describing and explaining how these devices work and how they can be applied. These texts have been at all levels up to the comprehensive advanced textbook standard, suitable for last year students, research workers and fully trained engineers. The present book is such an advanced text. There is no doubt that, especially as far as circuits and applications are concerned, it is comprehensive, sound and thorough. Unfortunately, all this wealth of data, formulae and scientific and technical knowledge is presented without any sparks of liveliness, and it has completely failed to give one any feeling for the subject. One finds a strange contrast between formalism, which goes into great detail, in some cases in irrelevant directions, and yet a complete failure to distinguish basic principles and explanations. The reviewer would almost be tempted to say that it is, for this reason, not a book to be recommended.

However, it would be unfair to dismiss this book too easily. It is a serious attempt at presenting after a brief introduction (which is unfortunately called Part I) a full treatment of semiconductor physics in Part II. This is intended to form the necessary basis for Part III, transistor design, construction and characteristics. Both these parts go quite extensively into the theory and fundamental principles of semiconductor device physics, and much information can be found therein. Finally Part IV is exclusively concerned with transistor applications, and there is hardly any aspect that is not fully mathematically described. Thus, some may find the book useful in spite of its lack of discrimination between the important basic concepts and less fundamental mathematical and technical details.

The book is quite well printed and has clear illustrations. The price of £4 14s does not seem expensive in view of the lavish amount in mathematical notation and the many figures.

K. HOSELITZ

La Modulation de Fréquence (Frequency Modulation)

By J. Marcus. 317 pp. 174 figs. Medium 8vo. Editions Eyrolles, Paris. 1960.

THE author has chosen to analyse the elements of frequency modulation before treating systems as a whole. This method together with the preliminary chapter devoted to definitions and basic principles makes the subject matter easy to assimilate. The system is built up through the succeeding chapters to the final sections dealing with receivers, multiplex operation and industrial applications. This last chapter gives descriptions of a telemetering system and of a multiplex system and also the design of a specific transmitter.

The intermediate chapters deal with methods of modulation, limiters and detecters, and receivers. A whole chapter (60 pages) is devoted to a very thorough analysis of noise including the effect of negative feedback.

Each chapter carries an appendix in which the more complex calculations are given thus presenting within the chapter itself a clear analysis without the need to digress to prove a particular expression. The work is thus clear and rigorous without being overloaded.

The author claims that his book is for the use of engineers and advanced students. The latter, if specializing in this field, will undoubtedly find the book most useful. So will the engineer but the amount of material and its rigorous presentation does not make it a quick-reference book. It is refreshing to find a book for intelligent readers rather than for those who wish for a snap answer without wanting to know the reason why. Nevertheless the book abounds with circuit diagrams and graphs with numerical scales relating to actual operating conditions and these are most valuable.

G. ASHDOWN

Principles of Feedback Control

By C. H. Wilts. 271 pp. 147 figs. Medium 8vo. Addison Wesley Pub. Co. Ltd. 1960. Price $9.75.

THE author is the Professor of Electrical Engineering in the California Institute of Technology. He has, however, the additional advantage of having acted as a consultant to industrial organizations.

As one would expect from the author's background, the book would be most useful to undergraduates who have reached an advanced stage in their academic career. Problems, and the answers, are provided at the end of each chapter.

The book is however closely enough linked with practice to be useful to graduates employed on servomechanism work. The reader's mathematical standards must be high in ordinary differential equations and complex variable theory. Although the author tries always to find a way round the use of the Laplace transforms for solving linear differential equations there is no doubt about the advantage a reader would have who can use the Laplace techniques.

The book is chiefly concerned with the stability problems found in the design of feedback systems. The earlier chapters are a fairly comprehensive introduction to the nomenclature and make-up of feedback systems and their study mathematically. A most helpful description of the frequency response approach leads to chapters on the stability of systems. These chapters include both the Routh-Hurwitz and Nyquist methods of analysis.

A chapter then follows on compensation technique which can follow from an analysis which has shown that the stability margins in a system under investigation are too small.

Frequency response and root locus approaches are used alternatively to give a choice of methods and possibly to please different view-points.

The later chapters in the book are much more individual. There is one on multiple-loop control systems which is followed by others on the response of closed loop systems. The use of the Describing Function in non-linear analysis is gone into in detail.

The book is clearly written, nicely printed, and has enough diagrams to help in the appreciation of the mathematical approach. Although a number of references are given, it is a little disappointing that, on a subject such as this, a much more generous supply is not tabulated.

J. R. BOUNDY

Electron Optics in Television

By I. I. Tsukkerman. Translated from Russian by L. A. Fenn. 290 pp. 138 figs. Medium 8vo. Pergamon Press Ltd. 1960. Price 55s.

THE Pergamon Press are doing a great service to the English-speaking public by their translations from the Russian, among which there are such masterpieces as the Landau-Lifshitz Course of Theoretical Physics. Unfortunately they cannot be congratulated on the present volume. There is no lack of good textbooks on electron optics with special reference to television, starting with the pioneer book of Maloff & Epstein and Zworykin & Morton. It may well be asked what purpose there is in translating a book which is neither better nor worse than some of the books on the same subject written in English, and which contains 90 per cent material which first appeared in English? Though the translator has done his best, there are quite a few slips which can hardly be avoided in such a double conversion. The image orthicon has become a super-orthicon, the checkerboard a chessboard etc. The re-anglicizing of the names of English authors from the Russian is particularly amusing. The Russian manner of writing equations has been retained, which is nearest to the German; arc tan instead of $\tan^{-1}$, *rot* instead of *curl* etc. which will cause the English students unnecessary difficulties. Even politics has helped to mar the effort. It is all right to mention the Russian Boris Rosing to have been the first who thought of applying the cathode-ray tube to television (about at the same time as the Frenchman Belin), but why deny V. K. Zworykin the authorship of the Kinescope and Iconoscope? The first author of an innovation or of a mathematical derivation is hardly ever mentioned in this book if there was a

EE 35 117 for further details

Russian (on the right side of the fence) who did it only 5 to 15 years later.

Nevertheless, if there were no good English books available on this subject the book could be recommended because 90 per cent of it is a good eclectic collection of classical German and American expositions, with the originals still recognizable in the somewhat second-rate illustrations. The remaining 10 per cent is mostly the author's own work, and related to the greatest part to the 'superorthicon'. This might conceivably be of interest to the very small number of specialists working on this device, but hardly to the much greater number of students who want a general introduction to the subject.

The reviewer has noted with some amusement that though the book is lavish with mathematical formulae, like the much larger book of Walter Glaser it forgets to mention the one which is by far the most important in television electron optics. D. B. Langmuir's formula of the limiting intensity in the writing spot. He also forgets the space charge limitation. He also ignores that John Pierce has proved long ago that post-acceleration brings no gain in combination with magnetic deflexion. It will be more merciful not to continue this list.

D. GABOR

Statistical Theory of Communication

By Y. W. Lee. 509 pp. 262 figs. Medium 8vo. John Wiley and Sons Inc. 1960. Price 134s.

THIS book was written as a text for first-year American graduate and advanced undergraduate students. The title may be somewhat misleading, for the book does not deal with communication in the information-theoretic (Shannon) sense. Rather, it deals with the theory and application of correlation functions and spectral analysis, Wiener-type statistical filtering, and linear system analysis and synthesis. These topics might be considered as a bridge between traditional Fourier methods and information theory.

The book is based on Professor Lee's extensive teaching experience at M.I.T. The exposition is very clear throughout, and good use is made of sensible physical arguments. Only the engineer's normal knowledge of the calculus and Fourier methods is presumed. Most of the material corresponds to the state of development of the late 1940's, however, and little guidance is given to more modern work.

Although Professor Lee's book cannot be ranked as a reference for specialists in communication theory, it is an excellent introductory text for those who wish to learn about the application of statistical notions to an important class of problems in communication engineering. Unfortunately those who can benefit most from the book probably cannot afford to buy it.

Moreover, while Professor Lee's book is very well done, the essential material already is contained in several textbooks published within the last few years. This multiplicity of titles in the communication-theory field, which are mainly from American publishers, is decreasing the market for any given book and is certainly driving prices upward. Publishers could provide a signal service by publishing but one or two comprehensive volumes per field of specialization, with each volume written and edited by a group of recognized experts. Perhaps the senior professional institutions might attempt to co-ordinate such efforts.

H. B. VOELCKER

Television Receiver Servicing (Vol. 1. Time-base Circuits)

By E. A. W. Spreadbury. 364 pp. 214 figs. Med. 8vo. 2nd Edition. Iliffe Books Ltd. 1961. Price 25s.

THIS is the second edition of a book written primarily for radio service engineers who wish to obtain a thorough knowledge of television servicing work. It assumes that the reader already has a reasonably good understanding of the principles of radio servicing and it extends this to the more complex circuits and techniques of television.

This edition has been completely revised to include all recent advances in television receivers. New drawings are included, and the numbering of the figures has been altered to a decimal system. On many of the diagrams component values have been added which enhance the value of the circuits.

Halbleiterprobleme, Vol. 5 (Semiconductor Problems)

Edited by Prof. F. Sauter. 343 pp. 132 figs. Med. 8vo. Friedrich Vieweg and Sohn. 1960. Price DM 48.

THE fourth volume of this series was reviewed in this journal in June 1959. The contributions to this fifth volume are mostly reports on the papers read at meetings of the semiconductor committee of the union of German physical societies held at Bad Pyrmont in 1959. But the first contribution by J. Jaumann on "Recent results of ultrared spectroscopy of solids" is based on a paper read before the meeting of physicists 1958 at Essen and has been published elsewhere before. The other contributions are the following: O. O. Folberth, "Survey of some physico-chemical properties of the $A^{III}B^{V}$ compound under special consideration of the phase diagram"; H. Krömer, "Negative effective masses in semiconductors"; O. Madelung "The behaviour of semiconductors in strong magnetic fields"; H. Schmidt. "Influence of band structure and mutual action of the electron-grid on the light absorption in semiconductors"; D. Geist, "The Maser (report)"; K. Zückler, "Appendix to the report: Silicon carbide, properties and applications as material for voltage dependent resistors"; K. Hauffe and W. Schottky, "Covering layer formation on metals"; J. Teltow. "Correction to the report on mutual action of faults in ion crystals and semiconductors."

As will be noticed the contribution by D. Geist falls somewhat beyond the scope of the title of the series. But there are two points of contact between masers and semiconductors. Firstly both can work as amplifiers though in different frequency ranges. And secondly one type of semiconductor, namely phosphorus donated silicon may be used as a material for a maser. Still this survey on masers will certainly be welcome.

Nearly all the contributions contain extensive lists of references to pertinent literature. The well produced volume concludes with a list of contents of all the volumes of the series so far published. It will be welcomed by all interested in semiconductors.

R. NEUMANN

Modern Dielectric Materials

Edited by J. B. Birks. 253 pp. 63 figs. Din. A5. Heywood and Co. Ltd. 1961. Price 42s.

THIS book is intended as an introduction to the chief dielectric materials which are of importance to the modern electrical industry. As there are many widely different materials involved, a team of authors, each actively engaged in research and development in the field of which he writes, has been assembled under the editorship of Dr. J. B. Birks of the University of Manchester. There is an introductory chapter by the Editor, followed by chapters on paper, hydrocarbon insulating oils, chlorinated hydrocarbons, natural and synthetic rubbers, synthetic high polymers, silicones, ceramics, glass, mica and micanite, and fibres and textiles.

CHAPMAN & HALL

MICROWAVE FERRITES

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A unified presentation of information on the preparation of ferrites and their application to wave propagation. *Illus.* 50*s.*

★

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A comprehensive summary of the present state of the art for the equipment designer, the student, and the static relay designer. *Illus.* 63*s.*

37 ESSEX STREET, LONDON, W.C.2

THE ELECTRONIC COMPONENT EXHIBITION

A description, compiled from information supplied by the manufacturers, of a further selection of the exhibits at the Exhibition of the Radio and Electronic Component Manufacturers Federation at Olympia, London, from 30 May to 2 June.

(Voir page 467 pour la traduction en français ; Deutsche Übersetzung Seite 475)

ANCILLARY DEVELOPMENTS LTD

Ancilo Works, Surrey Avenue, Camberley, Surrey

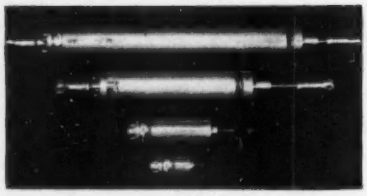
RECTILINEAR POTENTIOMETERS

(Illustrated below)

The ADR series of rectilinear potentiometers are designed to measure with extreme accuracy linear movements without the use of amplifiers and demodulators etc. Typical applications being feedback potentiometers on aircraft controls, machine tool control and vehicle suspension study.

The unit consists of a stainless steel operating shaft which is free to rotate about its own axis in addition to sliding in low friction bearings, this shaft is attached to the all-metal double contact wiper carrier.

The precious metal wipers operate on both sides of the precision wound mandrel and are kept in their due position by rhodium plated brass or nickel silver guide rods.



The anodized aluminium case and end plates with swivel bearings at one end completes the assembly. The use of swivel bearings permits measurement in more than one plane, an example being oscillatory motions.

These potentiometers are available with stroke lengths from 1in to 13in in a resistance range up to 1MΩ.

EE 35 751 *for further details*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

Crown House, Aldwych, London, W.C.2

VALVES AND CATHODE-RAY TUBES

Included in a new high performance range of valves for television receivers is the 30C17, a high gain triode-pentode of frame grid construction which is one of the first frequency-changer valves to be designed for a.g.c. operation in television tuners.

Another new high performance valve with frame grid construction is the 30F27, a tetrode r.f. amplifier with variable-mu characteristics for television tuners. Advantages over the more conventional double-triode connected in cascode lie in the smaller number of circuit components required, and in the simpler and often more compact layout that can be achieved.

Two frame grid h.f. pentodes for the i.f. stages of a television receiver are the 6F24, with a mutual conductance of 15mA/V at 10mA anode current, which will provide superior performance in a.c. or a.c.-d.c. receivers; and the 6F25, a variable-mu valve which can handle large input signals without cross-modulation, and is therefore a suitable common i.f. amplifier.

For vertical deflexion circuits of television receivers using 110° or 114° picture tubes, the 30PL14 is a high power triode/beam-tetrode with a higher available peak current that will, in many cases, permit economies to be made in output transformer design. The 30P19 is a beam power amplifier for horizontal deflexion output circuits; features in its design minimize spurious disturbances that might appear on the picture.

An efficiency diode for line deflexion output stages of 110° and 114° tubes, the U193 has a maximum peak heater-cathode voltage rating of 5·5kV.

The new Ediswan Mazda 19 and 23in picture tubes, types CME1901 and CME2301 respectively, which are now incorporated in certain receivers, were shown. They have been developed to improve picture presentation and provide one that is 95 per cent a true rectangle. This has been achieved through a more nearly rectangular tube face of larger radius of curvature. The new tubes can be compared with previous 17 and 21in types, CME1705 and CME2104.

New developments in Ediswan power valves are exemplified by a pre-production vapour cooled power triode. Vapotron type V1503, designed primarily for vibrator drive amplifier duty, but which can also be used in r.f. power applications; by a forced-air cooled power triode type 16J12 for transmitting purposes to which full filament voltage can be applied immediately; and by type 14D13, a radiation cooled triode with robust sintered glass base for relay and vibrator amplifiers and other a.f. and low r.f. applications.

EE 35 752 *for further details*

SYDNEY S. BIRD & SONS LTD

3 Palace Mansions, Palace Gardens, Enfield, Middlesex

U.H.F. TUNER

(Illustrated above right)

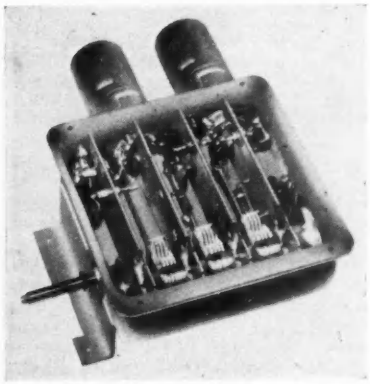
This tuner consists of a grounded grid r.f. amplifier and a self-oscillating mixer, it is designed to provide continuous tuning over the frequency range 470 to 790Mc/s, this is accomplished by using Lecher lines which are tuned by a three gang capacitor.

The tuning spindle is coupled to the tuning capacitor via a 5:1 reduction gear which is built inside the tuner unit.

At u.h.f. the mechanical stability of a tuner unit is of prime importance, this stability is achieved by using a deep drawn steel box in 16 gauge material. The box is partitioned by steel plates to form the necessary input, tuning and output compartments. Oscillator radiation is reduced to a minimum by using a copper foil gasket which is under compression due to a rubber pad and steel cover.

The wide band input circuit consists of a π-filter. This is designed to provide correct matching between the grounded grid input stage and the aerial. Alternative input connexions for balanced or unbalanced systems can be provided.

A continuously tuned band-pass filter provides bandwidth of 5 to 7Mc/s over the complete tuning range. Coupling between the primary and secondary tuned



circuits is by slots in the dividing partition. The band-pass filter is coupled to the mixer by an inductive loop.

A grounded grid self-oscillating mixer is used and this is designed to reduce the incremental frequency drift to a minimum.

The i.f. transformer is connected to the mixer via a filter in order to reduce radiation of energy from the oscillator through the i.f. section. Link coupling to the i.f. transformer is provided.

EE 35 753 *for further details*

PERMEABILITY TUNERS

(Illustrated on page 461)

These compact permeability tuners have been designed for use, with a capacitive input, in car radio, portable and similar transistorized receivers. The assembly consists of coils for the signal frequency and oscillator circuits whose inductance changes with variations in the

JH&P

OUTSTANDING FEATURES
OF THE C13 MILITARY WIRELESS SET

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ROBUST — FULLY SEALED — WEATHERPROOF
No netting — Crystal calibration
Simple controls — Two-knob tuning

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4201 channels at 2.5Kc/s spacing
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RF OUTPUT 16–25 WATTS
Automatic control of frequency, modulation and gain
Automatic quieting circuits

LOW POWER CONSUMPTION
24 volt power supply — Stand-by (receiver only)
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GROUND AND SKY WAVE
Voice and CW — Local and remote aerials
Minimum screening — Vehicle and ground stations

The C13 is the official replacement for the WS19HP set. It provides the extra-long ground-wave ranges required by mobile armoured fighting vehicles on active service with the British Army. Exceptional range, performance, simplicity of controls, rugged climatic protection and the elimination of all netting combine to make the C13 a versatile and highly serviceable equipment. It conforms in all respects to the Joint Services Specification Category K114G. You are invited to write to us for a booklet giving a comprehensive description of the set and its performance.

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EE 35 119 *for further details*

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Wide Ranges — **R** 0·001Ω to 10MΩ **L** 1μh to 1000h
C 1μμf to 1000μf **D** 0·001 to 50 at 1kc/s
Q 0·02 to 1000 at 1kc/s

Basic 1% Accuracy for R, L, C — 5% for D and Q. Not reduced at range extremes

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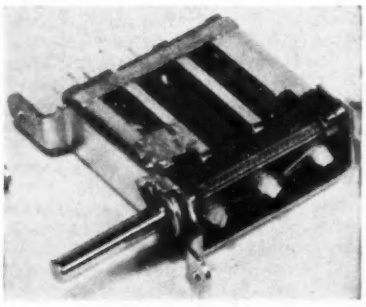
CL 35/119



inserted position of ganged cores through rotation of an integral tuning spindle.

All Cyldon RT 8 tuners are accurately pre-aligned to operate in agreed circuits. The only alignment operations required in the receiver being the adjustment of trimmer capacitors at the defined alignment frequencies.

In all cases tuners are supplied only with the basic variable inductances for the m.w. and/or v.h.f./f.m. band.

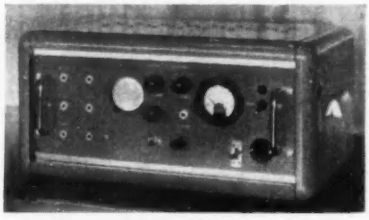
The illustration shows a three coil a.m. tuner.

EE 35 754 *for further details*

G. & E. BRADLEY LTD

Electrical House, Neasden Lane, London, N.W.10

G. & E. Bradley Ltd is an associate company of Joseph Lucas (Electrical) Ltd who undertake the sales and applications of semiconductor devices manufactured by the latter company.



DIODE INVERSE CHARACTERISTIC TESTER

(Illustrated above)

The Bradley diode inverse characteristic tester provides a visual indication of p.i.v. breakdown and the quality of junctions. The actual p.i.v. and the reverse leakage current can be measured on a meter incorporated in the instrument. Transistor leakage currents (I_{co}) may also be determined at the required voltages by considering the collector—emitter junction as a diode with emitter and base short-circuited. A four-position switch on the instrument panel provides a choice of test voltages between 250V and 1 500V, whereas another enables five current ranges to be read on the meter.

EE 35 755 *for further details*

DATA STORAGE UNIT

(Illustrated above right)

A data storage unit for the Anglo-American Scout satellite due to be launched this year, has been designed and developed for the Electron Physics Department of Birmingham University by G. & E. Bradley Limited. The unit will be used by this Department in experiments to measure electron density levels along the orbital path of the satellite.

Information on the maximum electron density occurring in the first 10sec of each 61sec cycle is gated into the store and read out towards the end of the period to either the telemetry system for immediate transmission or to magnetic tape for subsequent transmission to earth at a convenient time. The sequence of operation is erase, gate, read in, store and read out, this sequence being repeated every 61sec, the timing of each operation being derived from the satellite master clock.

The power consumption is very small, approaching 0·6mW per store at maximum output, this power being derived from the satellite solar power system.

The unit is constructed in standard module form and contains eight identical stores.

It is fully transistorized and extremely compact containing 180 components, mostly silicon transistors and diodes, in a space 1¼in by 5¼in diameter, and weighs about 8oz in unencapsulated form.

The unit has been designed to operate with absolute reliability during the expected life of the satellite and also to withstand the cyclic variations and extreme temperatures encountered in space.

EE 35 756 *for further details*

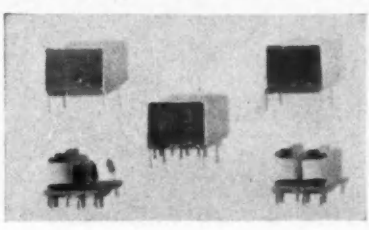
BRAYHEAD LTD

Kennel Ride, Ascot, Berkshire

MINIATURE I.F. TRANSFORMERS

(Illustrated below)

Brayhead Ltd have introduced several new designs of intermediate frequency transformers and oscillator coils suitable for use in transistor radio receivers. To meet the requirements of the designers of personal radio, the Company has commenced production of a sub-miniature range of components housed in screening cans 7mm square by 11mm high. These transformers which are single tuned and have Q factors of 110 are supplied with windings suitable to match all types of transistors currently in use for domestic radio.



Band-pass intermediate frequency transformers are now available having the advantageous feature of allowing the adustment of tuning cores to be carried out from the top of the can which has a base of 24mm by 12½mm by 19mm high. In this size can the final intermediate frequency transformer also incorporates the diode and filter capacitor and are a most suitable range of components for the conventional size portable receiver of high performance.

EE 35 757 *for further details*

BRUSH CRYSTAL CO. LTD

Hythe, Southampton, Hampshire

CERAMIC FILTERS

Made of a piezo-electric ceramic material these units, known as the Overtone Transfilter (T.O. series) and the Fundamental Transfilter (T.F. series), they eliminate the need for initial or subsequent adjustment. T.O. Transfilters are ceramic filters with impedance matching characteristics. The piezo-electric disk vibrates at the first overtone of its fundamental radial mode. It forms a four terminal network with a high impedance input and a low impedance output. With appropriate circuit design, the 'Overtone' Transfilter can replace the transformer or inductive and capacitive elements used in conventional frequency-selective circuits.

The T.F. Transfilter can replace an emitter by-pass capacitor. These components improve selectivity and long term reliability and simplify circuit procedure. They are suitable for printed circuits and can be mounted by automatic assembly techniques.

The components are not affected by humidity and give good high-temperature performance.

EE 35 758 *for further details*

VOLTAGE REFERENCES

Frequent demands for a voltage reference device covering varying currents, slope resistance and temperature have led to the development of the Brush Statavolt.

This patented device consists basically of a number of diodes in a series and/or parallel configuration with input and output characteristics to suit the individual designer.

It has a rugged mounting system suitable for most applications and is available in an aluminium alloy or plastic (nylon, melamine or p.v.c.) assembly. The aluminium alloy assembly acts as an efficient heat sink to allow increased dissipation, while the plastic-cased unit allows for high voltage diodes in series, as well as insulating the units from other components.

Typical applications vary from a 1·1V reference level at a nominal zero temperature coefficient, used as an electronic

standard cell, to a 300V stabilized power unit with 5V taps at a specified temperature coefficient.

EE 35 759 *for further details*

BURNDEPT LTD

Erith, Kent

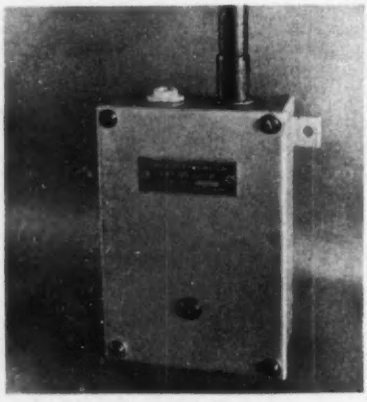
PROXIMITY SWITCH

(Illustrated below)

The BE.238 is a low cost, stable and sensitive proximity device which can be used for level control, counting, process initiation etc.

For level control purposes two models are available, BE.238 'fail to safe' for low level, and BE.238/HL 'fail to safe' for high level, and reliable control is possible on powders, fluids or granules, conducting or non-conducting. The BE.238 is designed to operate continuously under adverse industrial conditions, and operation is not affected by dust, moisture or vibration. Flame and explosion proof installation can be arranged.

The BE.238 relies on the fact that a crystal controlled oscillator has a critical value of tuning capacitance, which, when exceeded, causes the oscillation to stop very abruptly. The sensing probe forms



part of this capacitance and any additional capacitance sensed by the probe causes the oscillator to stop, which operates a relay carrying a set of change-over contacts. These contacts are utilized to carry out the control desired.

A change in capacitance of 0·05pF can be sensed. Coarse and fine preset controls are provided, and sensitivity can be adjusted on these to suit the application.

The BE.238 is capable of reliably sensing 1 000 articles per minute using the relay contacts to switch the control circuit. For higher sensing speeds a pulse may be obtained to feed any associated electronic equipment.

A wide range of standard sensing probes is available and probes can be designed to suit special requirements.

EE 35 760 *for further details*

CONTINUOUS LEVEL MONITOR

(Illustrated above right)

The continuous level monitor, BE.291, provides automatically the level indica-

tion of the contents of any material in liquid, powder or granular form providing this level may be translated into a corresponding electrical capacitance change.

In a typical installation, a sensing probe is suspended from the top of the tank or hopper. The contents are allowed to come in contact with the probe and cause an electrical capacitance change proportional to the length of the probe which has been covered. The capacitance change is translated by means of a proximity switch into a corresponding current change which is displayed on a moving-coil meter.

The tank contents information can be repeated at any reasonable distance by means of an external meter.

The distance between the sensing probe and the BE.291 is normally confined to 7ft, for longer cable lengths, a matching unit, BE.271 can be used.

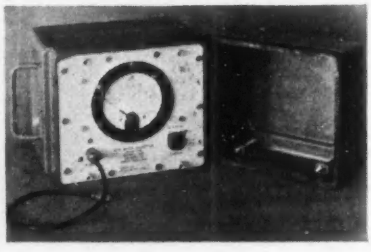
The BE.291 employs a patented electronic continuous sampling system. This is carried out without any mechanical moving parts, employing a capacitance actuated proximity switch. The conventional moving armature relay normally used in a proximity switch, has been replaced by a transistor. The sampling of the tank content is carried out 50 times a second, and this means that the BE.291 can respond to rapid changes in level. The system is inherently safe, as the failure of the electronic valve or transistor causes the sampling to cease and under failure conditions, the meter indicates 'tank full', whatever the level in the tank.

EE 35 761 *for further details*

WIDE RANGE POWER METER

(Illustrated below)

The BE.281 is a compact portable instrument for measurements of power up to 1·5W over the frequency range



1kc/s to 1 000Mc/s. The unit is mounted in an R.A.E. Standard Equipment Case.

The power meter, is accurately matched to 50Ω by the use of a coaxial load resistor, mounted in an exponential cavity. The resistor, of the carbon fired on ceramic type is tapped at 5Ω from the earthy end, and a silicon diode is used to rectify the signal at this point.

Indication is provided on a 4in sealed meter of 50μA sensitivity. Three scales are provided: 0 to 1·5W, 0 to 300mW and 0 to 100mW f.s.d. Lowest calibrated points on the three ranges are 50, 10 and 5mW, respectively.

A spring-loaded toggle switch is always biased to the 1·5W position thus protecting the more sensitive ranges. The input termination comprises a 500Ω B.N.C. socket.

A particular feature of the BE.281 is its fast response. This is in contrast to rather sluggish bolometer type of power measuring instruments. Fast response means that the power meter is suitable for output measurements of radio transmitters such as pulsed air-sea rescue beacons and any low, modulated power levels in the v.h.f.-u.h.f. band.

EE 35 762 *for further details*

ELECTRO ACOUSTIC INDUSTRIES LTD

Stamford Works, Broad Lane, Tottenham, London, N.15

MINIATURE LOUDSPEAKERS

(Illustrated above)

A range of 'Compact' loudspeakers has been introduced which is intended primarily for use in portable transistor receivers. The range comprises four loudspeakers having diameters of 2in, 2½in, 3in and 3½in. All of these loudspeakers have high acoustic efficiency and the average frequency response of the two larger models is 200c/s to 5kc/s and 150c/s to 7kc/s respectively.

EE 35 763 *for further details*

ELLIOTT-AUTOMATION LTD

34 Portland Place, London, W.1

VARIABLE COAXIAL DIRECTIONAL COUPLER

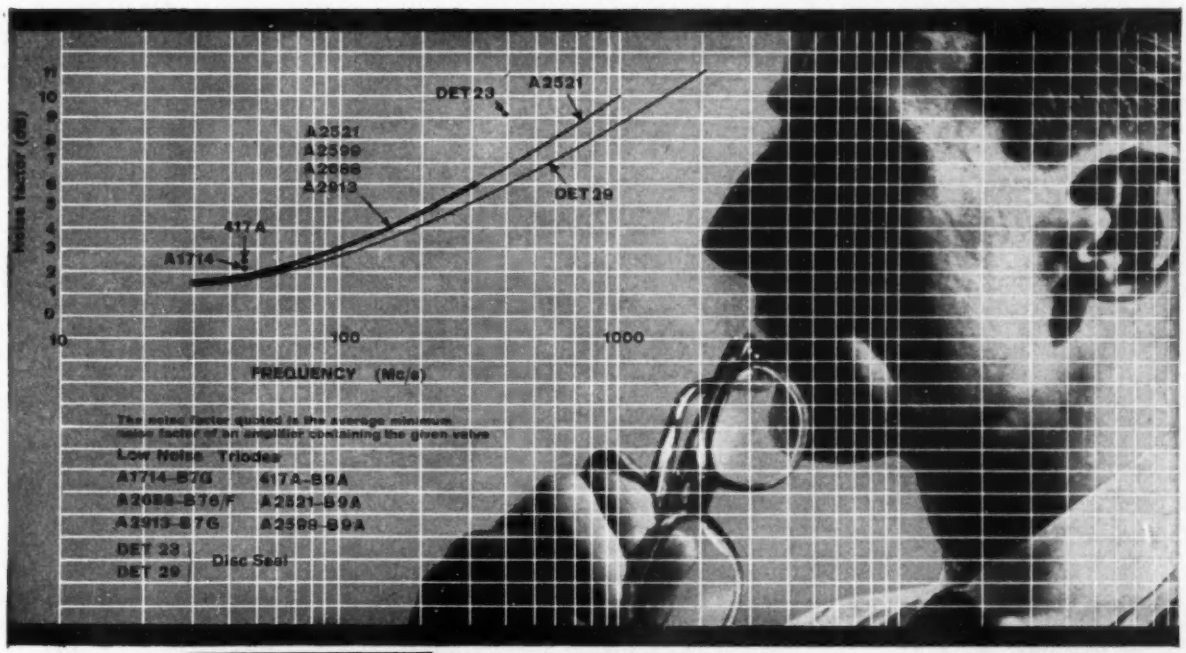
(Illustrated on page 463)

This prototype instrument, produced by the Radar Division of Elliott Bros. (London) Ltd, is based on the 'back-coupling' effect between two adjacent coaxial lines with a slot in the common wall. Variation of the relative positions of the specially shaped inner conductors

WE CAN GET YOU OUT OF A ■

low noise valve PROBLEM

Last year our 300 engineers solved many thousands of valve problems from all sides of industry. If you have a valve problem, why not take advantage of their expert advice? Simply telephone RIV 3431 and ask for our Technical Information Centre or write to the address below.



G.E.C.

THE M-O VALVE CO LTD

BROOK GREEN HAMMERSMITH LONDON W6

EE 35 121 *for further details*

NEW HIGH POWER TRIODE BEAM TETRODE

EDISWAN MAZDA 30PL14

The 30PL14 Triode Beam Tetrode is intended principally for use in frame deflection circuits of television receivers using 110° and 114° cathode ray tubes. The tetrode section has been designed to operate with a low ratio of screen to anode current whilst the available peak anode current and anode dissipation are higher than in the 30PL13. The higher available peak anode current will, in many cases, permit economies in output transformer design. The triode section is a general purpose triode with identical characteristics to the 6/30L2, and that of the 30PL13, for use as a deflection drive voltage oscillator, frame sync. pulse separator, etc.

Heater Current (amps)	I_h	0,3
Heater Voltage (volts)	V_h	16

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

		Triode	Tetrode
Anode Dissipation (watts)	$p_{a(max)}$	1	8
Screen Dissipation (watts)	$p_{g2(max)}$	—	2
Peak Anode Voltage (Pulse positive) (kV)		—	2*
Peak Anode Voltage (Pulse negative) (kV)		—	0.5*
Anode Voltage (volts)	$V_{a(max)}$	250	250
Screen Voltage (volts)	$V_{g2(max)}$	—	250
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)rms}$	150†	150†
Mean Cathode Current (mA)	$I_{k(av)max}$	—	75
Resistance Grid 1 to Cathode			
Self Bias (MΩ)		—	2
Fixed Bias (MΩ)		—	1

* Maximum pulse duration 5% of one cycle with a maximum of 1 msec.

† Measured with respect to the higher potential heater pin.

TRIODE CHARACTERISTICS

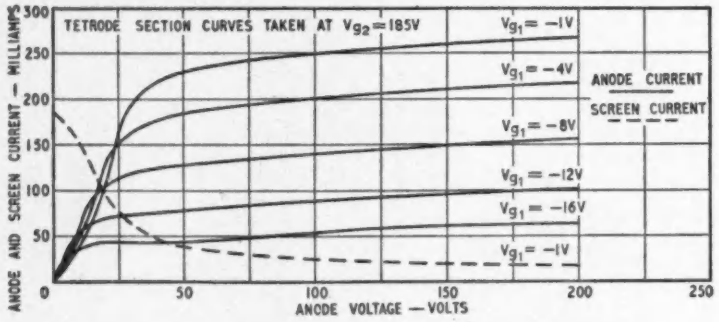
Anode Voltage (volts)	V_a	200
Anode Current (mA)	I_a	10
Grid Voltage (volts)	V_{g1}	7.7
Mutual Conductance (mA/V)	g_m	3.4
Amplification Factor	μ	18

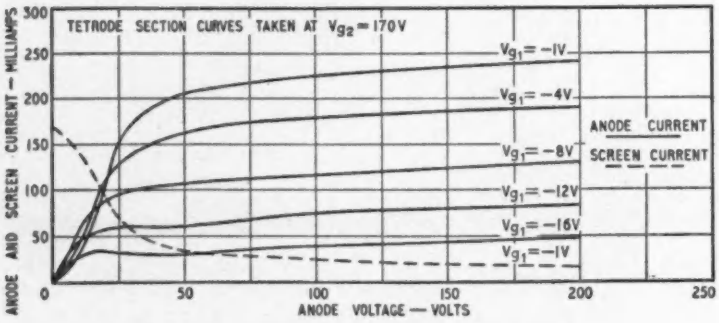
TETRODE OPERATION IN FRAME TIME BASE

Allowance must be made in circuit design, not only for component variation, but for valve spread and deterioration during life. Values of total tetrode peak anode current, for an average valve when new and at the assumed end of life point for any valve, are as follows :—

	V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)
Average New Valve	55	170	− 1	210
Assumed End of Life Condition	50	170	− 1	135
Average New Valve	55	185	− 1	235
Assumed End of Life Condition	50	185	− 1	151

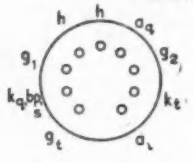
Tentative Characteristic Curves of Ediswan Mazda Valve Type 30PL14



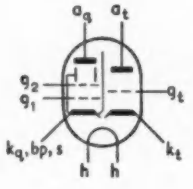


Mounting Position: Unrestricted

Base: B9A (Noval)



VIEW OF FREE END



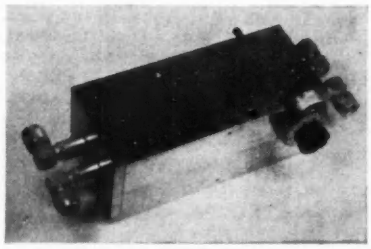
Maximum Dimensions (mm)

Overall Length	78.5
Seated Height	71.5
Diameter	22.2

Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 9797. Grams: Sieswan, Westcent, London

EDISWAN
MAZDA

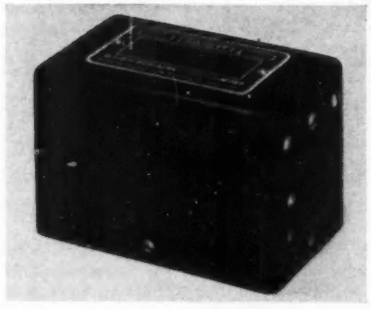
TA 15/102/5146



controls the amount of power transferred from the main transmission line into the subsidiary line. The coupled power can thus be varied smoothly from −6dB to −40dB down on that in the main line. Coupling indication is by a digital reading dial attached to the drive shaft, the calibration accuracy being ±0·1dB. Over a frequency range of an octave, the maximum coupling variation, for any one setting is less than 2dB.

With the unused pair of connectors correctly terminated with matched loads (which may be built into the device), the input voltage standing-wave ratio is less than 1·3 (0·77) at maximum coupling, and less than 1·2 (0·83) at all other settings. One model is at present available, covering the ranges 600 to 1 200Mc/s; power handling capabilities are 10W mean, and 10kW peak.

EE 35 764 *for further details*



TORQUE—MOTOR AND SHAPING AMPLIFIERS

(Illustrated above)

Elliott transistor torque-motor and shaping amplifiers are designed to work at temperatures of up to 100°C. They are especially suitable for use in conjunction with the Elliott range of torque motors, but can also be used with other types provided the appropriate impedance is available.

The power stage has variable gain and low drift. The frequency response of the amplifier and torque-motor shows a phase-lag of 90° at over 200c/s.

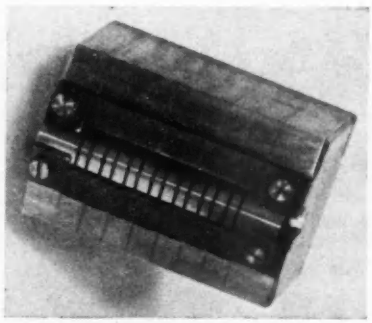
The shaping amplifier is a versatile amplifier with an open loop gain of 16V/μA. This amplifier also has a low drift performance.

EE 35 765 *for further details*

MAGNETIC RECORDING HEADS

(Illustrated above right)

The ferrite-core metal faced heads used in the Elliott instrumentation magnetic



recording system are now available as individual plug-in units.

These recording heads are suitable for analogue or digital recording systems using any of the conventional forms of modulation. The combination of ferrite cores and greatly reduced gap widths permits recording and reproducing frequencies at 4kc/s per inch tape speed.

Standard heads are produced to British (S.B.A.C.) or American (I.R.I.G.) specifications, 16 or 14 tracks per inch, in line or interleaved. A variety of track configurations is available for ¼in, ½in, or 1in tape.

The method of construction (which is protected by patent) gives excellent azimuth alignment between tracks and eliminates the need for costly head replacements. It is only necessary to replace the pole face, when head wear occurs, to obtain 'as new' performance.

The track spacing is 0·06 or 0·12in in line and 0·07in interleaved while the track width is 0·0325in or 0·075in in line and 0·05in interleaved. The gap width is 3 to 5μ. The inductance of the recording head is 0·5mH and that of the playback head 10 to 15mH.

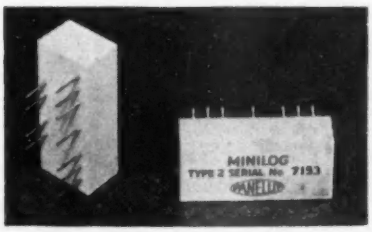
EE 35 766 *for further details*

TRANSISTORIZED LOGIC SYSTEM

(Illustrated below)

Panellit Limited, a member of the Elliott-Automation Group, exhibited a new, fully encapsulated version of the 'Minilog' solid-state transistorized logic system for industrial sequencing and control applications.

'Minilog' can be applied to both simple and complex logic systems. It is designed to replace relays, stepping switches and similar devices, increasing both speed and reliability of performance. It is completely solid-state, requires no maintenance and ensures trouble-free operation under stringent environmental conditions.



Two types of 'Minilog' elements are available. One has six inputs, giving an 'inverted and' function, and an output which can drive up to five inputs; the other incorporates an emitter-follower and its output can drive up to 25 input. Both are the same size (2·0in by 0·85in by 0·63in) and occupy slightly more than one cubic inch of space. They have 11 tinned-copper wire leads, 0·32in in diameter. Transistor power elements can be supplied as top and bottom-end drivers for actuating solenoids and similar devices up to a maximum of 50V 1A.

Forty-eight 'Minilog' elements can be mounted on a s.r.p.b. board, measuring 10in by 17in. A special 'Minilog' chassis, with gold-plated plugs and sockets to provide inter-board, signal and power connexions can accommodate up to 12 of these boards.

EE 35 767 *for further details*

ENTHOVEN SOLDERS LTD

Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16

POWER TRANSISTOR PRE-FORMS

These pre-forms have been designed to provide intimate contact between a power transistor and its heat sink and thus to ensure maximum heat transference.

In cases where the transistor base is manufactured from cast material, surface imperfections create air gaps between the transistor base and the unit on to which the component is bolted. To a slightly lesser degree, the same applies to bases that have been machined. In either case, heat transference is far from perfect.

The use of an Enthoven power transistor pre-form between the two metal faces takes up any slack created by imperfect surfaces, giving 100 per cent contact, thus ensuring efficient heat transference from the transistor base. Several other materials from which pre-forms can be made also give favourable results but, by reason of their corrosive nature under certain conditions, have to be ruled out from the point of view of inter-service requirements. Power transistors with an eliptical base (the type in question) are currently produced in several countries, all conforming to a common specification in order that inter-country service requirements are met without difficulty, and the Enthoven pre-form should therefore give uniform results on operating temperatures up to 50°C.

EE 35 768 *for further details*

ERIE RESISTOR LTD

1 Heddon Street, London, W.1

MINIATURE CERAMIC CAPACITORS

The style 4T Transcap is a miniature disk type high capacitance ceramicon intended for low voltage coupling or bypassing in transistor circuits. It has a diameter of 0·594in and is 0·156in thick. The capacitance is 0·5μF and it will operate at 3V d.c. The power factor is 5 per cent measured at 1kc/s. Other capacitance values and working voltages will be introduced in due course.

The styles Y and Z are sub-miniature tubular ceramicons primarily intended for incorporation in i.f transformers. Both have a diameter of 0·098in; the style Y is 0·22in long and the style Z 0·3in. The capacitance range of the former is 150 to 200pF and the latter 201 to 300pF. The working voltage of both types is 150V and the power factor 0·2 per cent.

The 'Discoidal' is a miniature feed-through ceramicon with a capacitance of 1 000pF and a working voltage of 350V d.c.

The compact design of the Discoidal feed-through permits the current to fan out in a 360° pattern from the centre electrode, providing the shortest possible electrical path between the centre terminal and the chassis. The internal series inductance is thus kept at a minimum: relatively heavy and short terminals ensure minimum external inductance, associated permanently with capacitors. These features make the Discoidal suitable for all v.h.f. and u.h.f. applications. The unit is hermetically sealed to provide mechanical rigidity and resistance to tropical exposure.

EE 35 769 *for further details*

FORTIPHONE LTD

92 Middlesex Street, London, E.1

MINIATURE RELAYS

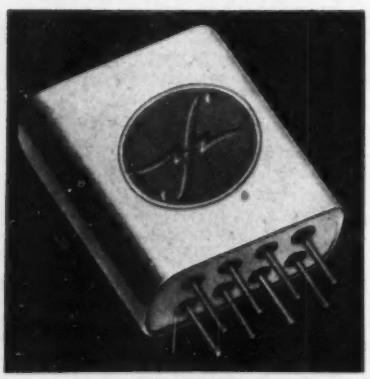
(Illustrated below)

This relay, known as the type G.100 has been developed for the Ministry of Aviation as a special quality component for use in guided weapons.

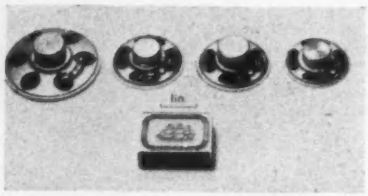
A balanced armature design is employed and to reduce contact contamination gold alloy contacts are used while the coils and contacts are sealed in separate compartments.

The relays will operate over a temperature range of −55°C to +125°C and will withstand accelerations of up to 100g. The contact rating is 0·3A at 50V d.c. and operating coils are available for voltages between 1·5 and 48V. The operate/release time is less than 15msec and the contact resistance less than 40mΩ (at 10mV).

Both two- and four-pole changeover versions are available. The former measures 0·8 by 0·9 by 0·37in and the latter 0·8 by 0·9 by 0·7in.



EE 35 770 *for further details*



GOODMANS INDUSTRIES LTD

Axiom Works, Wembley, Middlesex

SUB-MINIATURE LOUDSPEAKERS

(Illustrated above)

A new range of sub-miniature loudspeakers is now available. These have a flat chassis construction and small magnet assemblies which give minimum interference with component layout.

There are five sizes in this range—2in, 2¼in, 2½in, 2¾in, and 3in, and there are three magnet sizes to each model. In addition the range is doubled by the availability of inverted versions of the foregoing. All are available with impedances ranging from 3 to 80Ω and are fitted with ultra high efficiency magnet systems.

EE 35 771 *for further details*

HUGHES INTERNATIONAL (U.K.) LTD

Glenrothes, Fife, Scotland

SWITCHING DIODES

The range of switching diodes manufactured at this new Scottish factory includes a series of germanium point contact diodes designed primarily for industrial applications where the special features of point contact diodes, for example, very good transient response and low capacitance, are of value. The germanium range is completed by a series of gold bonded diodes which have very good forward conductance and transient response.

The range of silicon diodes includes the HS10 series of general purpose diodes which can be used as small rectifiers or for switching at repetition rates up to 100kc/s. Of particular interest in this range is the newly introduced HS1020, a 200V diode with a guaranteed back-to-front resistance ratio of 5 by 10⁸ under rated conditions. The HS11 series of computer diodes completes the range, providing very good transient response (stored charge 700pC typically) together with high reverse voltage rating and low reverse leakage.

EE 35 772 *for further details*

JAMES A. JOBLING & CO. LTD

Wear Glass Works, Sunderland

METAL OXIDE FILM RESISTORS

A new range of metal oxide film resistors has now been introduced and will be known as the style 'CJ'. The range includes the CJ20 which is a ¼W fully insulated type with a length of 0·375in and a diameter of 0·15in and the CJ32, a 1W fully insulated resistor with a length of 0·5in and diameter of 0·2in. These are in addition to the 2W resistor which has been in production for some time and which will now be designated type CJ42.

These resistors are intended primarily for use in computers and similar equipment.

EE 35 773 *for further details*

THE M.O. VALVE CO. LTD

Brook Green, Hammersmith, London, W.6

VALVES AND CATHODE-RAY TUBES

The TWC5 is the latest addition to the range of periodically focused travelling wave tubes now in production at Hammersmith. It is a travelling wave tube power amplifier capable of delivering 11W in the 5·8 to 8·2kMc/s band, and designed to give a cold input and output v.s.w.r. of less than 2:1. It has been specially developed for multi-channel telecommunications systems, and has a maximum power output of 15W in the 5 925 to 6 425Mc/s band. The match is better than 1·4 in the narrower bandwidth. Similar performance can be obtained in other narrow bands.

The LD603 is a new 5in instrument cathode-ray tube with high efficiency post deflexion acceleration giving high deflexion sensitivity. The tube, which is at present being prepared for production at Hammersmith, has a deflexion sensitivity in the X direction of 9·5V/cm and in the Y direction of 3·7V/cm. A new form of p.d.a. has been employed in this tube to give three times the deflexion sensitivity of helical p.d.a. tubes while maintaining a scanned area of 10cm by 6cm.

EE 35 774 *for further details*

MINIATURE ELECTRONIC COMPONENTS LTD

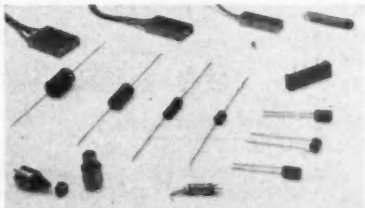
The Lye, St. John's, Woking, Surrey

MINIATURE POTENTIOMETERS AND RESISTORS

(Illustrated below)

The M.E.C. range of multi-turn trimmer potentiometers has been extended and now includes a printed circuit model. Double and triple models are offered for installation where this integral construction can make for greater space saving. All types are now available with a slipping clutch as an alternative to positive end stops. These miniature potentiometers are housed in one-piece anodized aluminium cases and fitted with solder tags or flexible leads. Seventeen standard values are available from 10Ω to 125kΩ and they will operate over a temperature range of −55° to +150°C, dissipating 2½W at 50°C.

A new range of 15 types of precision wirewound resistors includes five miniature models of which three have been



specially designed for printed circuit applications.

Of particular interest is the newest M.E.C. development; a miniature toggle switch of only ¼in diameter and ½in body depth. In spite of its very small size this switch is rated at 1A at 50V d.c.

EE 35 775 *for further details*

MORGANITE RESISTORS LTD

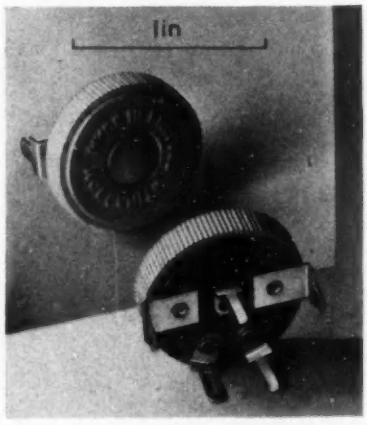
Bede Trading Estate, Jarrow, Co. Durham

MINIATURE POTENTIOMETER

(Illustrated below)

A new miniature edge control, the type 56, introduced by Morganite Resistors Limited will be of particular interest to designers of small transistorized receivers. The overall diameter of the control is only 0·8in and the printed circuit tags provide a convenient method of mounting the component.

The use of a well proved resistance



element with a new contact design results in low rotational noise despite the small physical. A reliable single-pole switch of robust construction is fitted.

The potentiometer has a power rating of 0·25W at 25°C, and a maximum anticlockwise termination resistance of 1Ω. The switch is rated at 50V, 250mA (maximum) and has a contact resistance of 0·02Ω (up to 0·05Ω after 10 000 operations on full load).

EE 35 776 *for further details*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

SUB-MINIATURE TANTALUM CAPACITORS

This is a new range of sub-miniature tantalum electrolytic capacitors suitable for transistor equipments.

The tantalum pentoxide dielectric formed within the capacitor is very much thinner and can withstand a higher voltage than the more conventional aluminium oxide. Hence an increased voltage-capacitance product is obtained, resulting in smaller physical dimensions.

The range comprises 10 types graded according to their capacitances and voltage ratings in cans of three different sizes.

The smallest can measure only 0·08in by 0·2in and houses a capacitor of 0·64μF, 10V working; at the other end of the scale capacitors as large as 40μF, 2·5V working or 16μF, 6·4V working are in cans scaling only 0·12in by 0·35in.

Their minute dimensions make the new capacitors particularly suitable for transistorized hearing aids, personal receivers and the like, where space is at a premium. Due to their ability to withstand shock and vibrations, and to work satisfactorily at very low atmospheric pressures, they can be used successfully in airborne equipment.

The normal maximum temperature is 50°C, but 60°C is permissible for 12 hours operation in any 24. If the temperature does not exceed 30°C the working voltage may be increased by 10 per cent.

The new capacitors are contained in hermetically sealed, silver tubular cans insulated externally by a coating of plastic material.

EE 35 777 *for further details*

SOLID DIELECTRIC VARIABLE CAPACITOR

This is a new miniature, solid dielectric, twin-gang capacitor designed for tuning pocket radio sets.

The two sections have capacitances of 0 to 180pF (aerial tuning) and 0 to 80pF (local oscillator tuning). Each section incorporates a 0 to 6pF trimmer.

Features of this new capacitor include: accurately aligned brass rotor and stator; absence of microphony; high electrical stability and mechanical sturdiness. The capacitor is housed in a dust-proof cover of synthetic resin measuring only 0·787in square by 0·59in deep. Mounting is by two tapped holes on the same surface as the spindle, the holes being positioned to line up with the standard 0·1in printed board grid. The terminal pins project downwards enabling the capacitor to be soldered directly into a printed circuit.

EE 35 778 *for further details*

SOLID DIELECTRIC TRIMMER

(Illustrated above right)

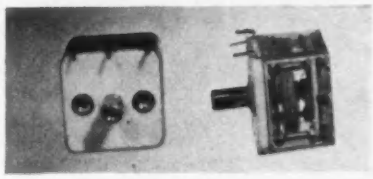
This new solid dielectric trimmer provides usefully large variations in capacitance, yet occupies very little height above the surface of a printed wiring board.

The capacitance range is from 1·5pF to 60pF, with an accuracy of adjustment better than ±0·12pF, and the maximum working voltage is 300V d.c. The seated height of the trimmer is 0·315in and its maximum surface is 0·55in square.

The trimmer is housed in a dust-proof casing of clear synthetic resin, which is shaped to cover the slotted end of the spindle to prevent side-slip of the screwdriver during adjustment. Three terminal pins, spaced to conform to the standard 0·1in printed board grid, project downwards, permitting direct soldering into a printed circuit.

The small dimensions of the trimmer suit it for a wide range of applications in transistor equipments.

EE 35 779 *for further details*



HYBRIDS AND BALANCED MIXERS

Mullard Equipment Ltd has developed a new range of coaxial balanced mixers and coaxial hybrids for use in microwave receivers at frequencies between 1·0Gc/s and 11·5Gc/s.

The salient features of these new microwave components are wide frequency coverage without tuning, and very small physical dimensions compared with the waveguide equivalents. They are therefore particularly suitable for use in untuned receiver circuits.

Both hybrids and the mixers are based on a newly designed phase-reversal hybrid circuit capable of operating over a 3:1 frequency range without tuning. The balanced mixer is obtained by building into the hybrid suitable mixer crystals and associated matching circuits.

The new hybrid circuit is a development of the conventional ring hybrid in which a length of line is replaced by a phase-reversal circuit, the performance of which is substantially independent of frequency. Besides eliminating a frequency-conscious electrical length, this arrangement also converts the conventional circuit into a symmetrical four-terminal structure giving a high degree of stability over a wide range of frequencies.

The complete range comprises five mixers and five hybrids, which between them provide coverage of the L1, L2, S, C and X bands. They are fitted with standard C-type or N-type coaxial connectors; waveguide terminations can be supplied if required.

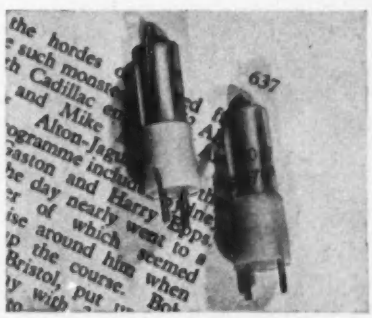
EE 35 780 *for further details*

MINIATURE ELECTROLYTIC CAPACITORS

(Illustrated below)

The present range of Mullard miniature electrolytic capacitors contains 22 types covering capacitances between 0·8μF and 200μF and working voltages between 25V and 4V.

Now, a further 18 types have been released which extend the range of



capacitance available to 640μF and the maximum working voltage to 64V d.c.

The capacitors are graded according to capacitance and working voltage in cans of five different sizes. The smallest size of can (0·39in by 0·12in) contains, for example, capacitors of 0·8μF 25V d.c. working, or 4μF 4V d.c. working. The largest size (0·35in by 1·2in) houses capacitors as large as 640μF 2·5V d.c. working or 32μF 64V d.c. working.

Capacitors in the three largest can sizes are available specially modified for printed board mounting. These are supplied with yellow plastic base through which two connecting wires protrude ready for direct soldering to the board.

EE 35 781 *for further details*

CERAMIC TRIMMER CAPACITORS

(Illustrated below)

This is a new range of small high quality trimmers, designed for use in professional communications equipment.

The range comprises three types with capacitances of 0·7pF to 3·7pF, 0·8pF to 6·8pF, and 0·9pF to 12·9pF respectively. All three types have a ceramic dielectric and are rated for a working voltage of 400V d.c. They are tropic-proof and will operate over a temperature range of −50°C to +100°C.

The trimmers are of tubular construction with an external diameter of 0·23in and a seated height of 0·39in, 0·51in or 0·75in depending on capacitance. A threaded shank provides single hole fixing, and the spiral cut plunger is slotted at both ends, so that the trimmer may be adjusted from below or above the chassis.

EE 35 782 *for further details*

R. B. PULLIN & CO. LTD

Phoenix Works, Gt. West Road, Brentford, Middlesex

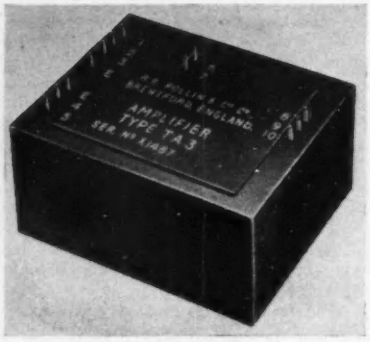
TRANSISTOR AMPLIFIERS

(Illustrated above right)

The amplifier unit type TA.1G unit uses latest type transistors and is designed to operate size 10 servo motors or motor generators. It produces a power output of 4W when operated in an ambient temperature of +55°C and delivers 6W at temperatures below 50°C.

The amplifier is primarily designed for operation from a 26V 400c/s supply but it may alternatively be powered with an 18V d.c. supply.

The type TA.3 amplifier (illustrated) is designed to provide control-phase power for servo motors up to and including size 15 but can also be used for other applica-



tions when operating through an external centre-tapped transformer. It will provide a power output of 7W in an ambient temperature range of −40°C to +70°C when operating from a 13—0—13V 400c/s supply. The input characteristic is such that a 150mV input signal will produce a 4W output.

EE 35 783 *for further details*

SEALECTRO CORPORATION

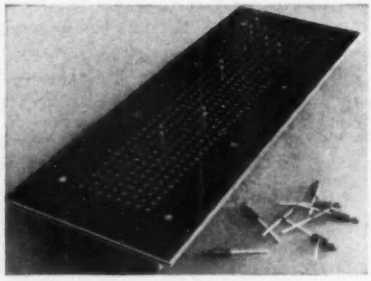
Hersham Factory Estate, Walton-on-Thames, Surrey

PROGRAMMING BOARDS

(Illustrated below)

The versatile 'Sealectoboard' programming system is available in a number of forms. The principle of 'Sealectoboard' is rows of beryllium copper strip contacts mounted in superimposed planes at right-angles to each other. Programming is accomplished by the insertion of shorting pins. Any number of sockets can be included to specification. A coaxial plug is also available, the body of which can contain a diode or other component, giving a digital or substitution facility.

Recent introduction is an individual socket which complements the normal type of bussed sockets and which gives



even greater flexibility to the system. Although designed as a 'cordless' programming system, plugs are available for wiring as normal 'patch cords' for use with single deck boards.

EE 35 784 *for further details*

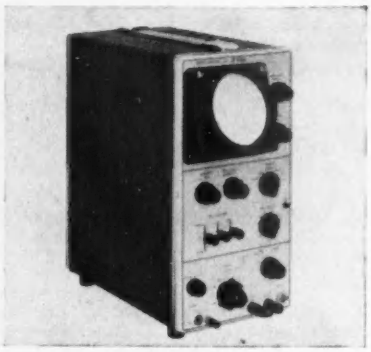
TELEQUIPMENT LTD

313 Chase Road, Southgate, London, N.14

MEASURING OSCILLOSCOPE

(Illustrated above right)

The S.42 has been developed primarily for applications involving high writing



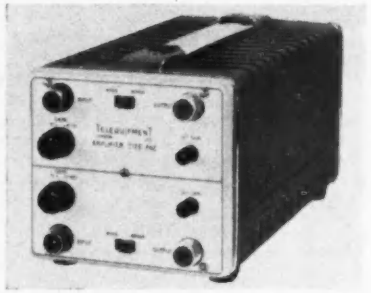
speeds at low repetition rates. A 4in spiral p.d.a. cathode-ray tube is employed which makes it possible to see and photograph, a single 1μsec pulse. The Y amplifier has a bandwidth of d.c. to 500kc/s on high gain and d.c. to 6Mc/s on low gain the maximum sensitivity on the former being 10V/cm and on the latter 100mV/cm. A calibrated input attenuator gives direct reading of a.c. or d.c. input voltages from 10mV/cm to 50V/cm. The calibrated time-base has 18 preset sweep speeds from 1μsec/cm to 500msec/cm. An X expansion control provides continuously variable expansion up to 10 screen diameters. Triggering may be automatic or selective which enables the time-base to be triggered from any selected part of the input waveform.

EE 35 785 *for further details*

TWIN-CHANNEL PRE-AMPLIFIER

(Illustrated below)

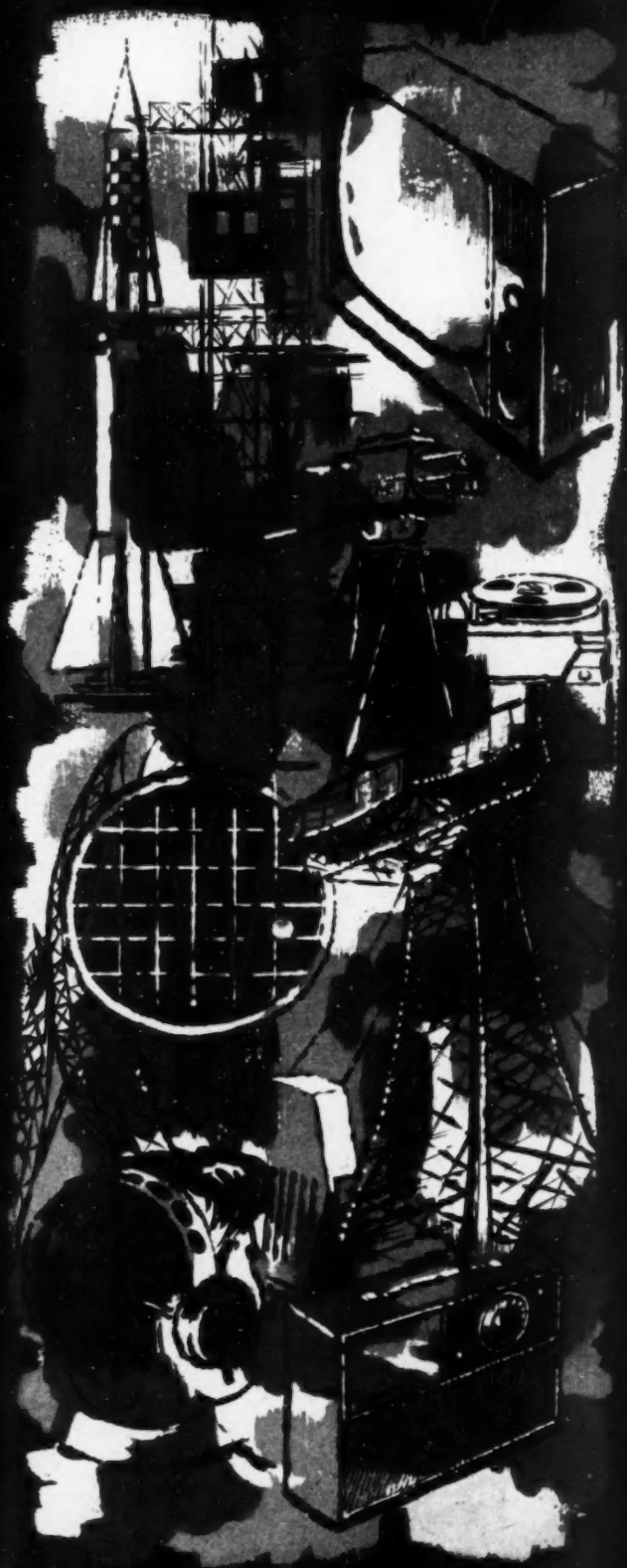
The PA2 has been developed for applications calling for high sensitivity such as those found in the medical, biological and electro-mechanical fields. It has two independent amplifiers with a high degree of separation, each amplifier employing



two pentodes in cascade with cathode-follower output. The power supply is self-contained, and stabilized h.t. ensures complete gain stability.

Although primarily designed for use with the double beam 'Serviscope', the PA2 may in fact be used with any oscilloscope in the Telequipment range to give a maximum calibrated sensitivity of 1mV/cm. The hum and noise level being extremely low, the Pre-amplifier may be used with the type S42 or S42A to give maximum sensitivity of 100μV/cm.

EE 35 786 *for further details*



the marvels of today's electronics rely in no small way upon

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Braid	Bonding, Impregnating or Coating Material	Temperature Category	Dielectric Strength
Terylene	Varnish (Oil Based)	120 C Class E	3,000 V.
Cotton or Rayon	Varnish (Oil Based)	105 C Class A	1,500 V. or 3,000 V.
Glass Braid	Varnish (Oil Based)	120 C	1,500 V. or 3,000 V.
Glass	P.V.C.	130 C Class B	5,000 V.
Glass	Silicone Resin	250 C Class H	800 V.
Glass	None (Heat treated)	450 C	600 V.
Glass	Identification Dye	450 C (Colours fade 180 C)	600 V.

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London W.5 Tel: EALing 7733

The Highest Sensitivity
and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.

fig. 1 Gain characteristics

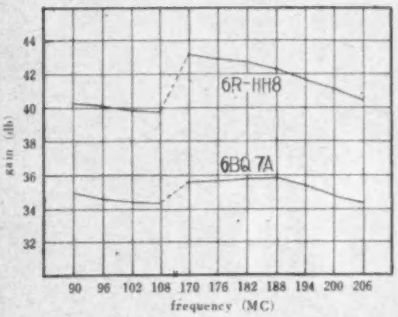
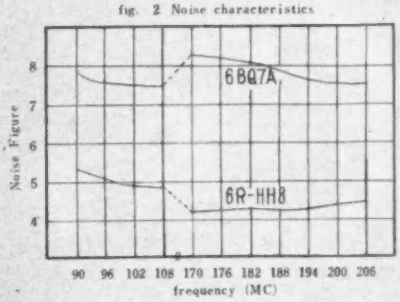
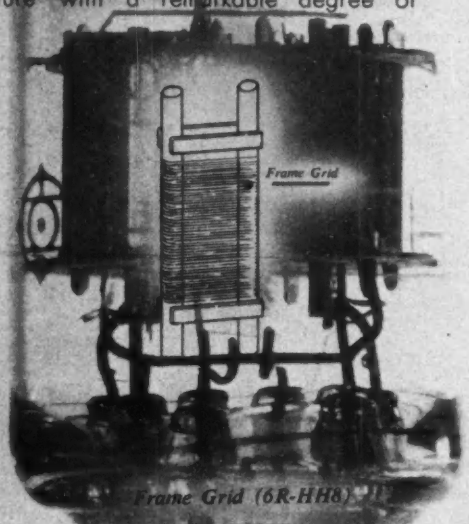


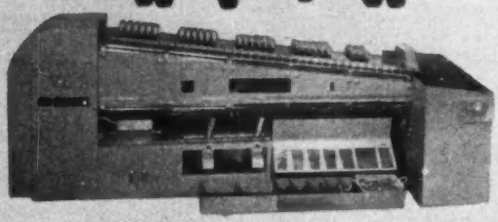
fig. 2 Noise characteristics





Frame Grid (6R-HH8)

Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.



Automatic tube testing equipment

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO

Le Salon des COMPOSANTS ÉLECTRONIQUES

Le Salon des Composants Electroniques. Une description, basée sur des renseignements fournis par les fabricants, d'un choix de matériels exposés au Salon de la Fédération des Fabricants de Composants Electroniques et de Radio, à l'Olympia de Londres, du 30 mai au 2 juin 1961.

Traduction des pages 460 à 466

ANCILLARY DEVELOPMENTS LTD

Ancillo Works, Surrey Avenue, Camberley

POTENTIOMÈTRES RECTILINÉAIRES

(Illustration à la page 460)

La série des potentiomètres rectilinéaires ADR est destinée à la mesure extrêmement précise des mouvements linéaires sans utiliser des amplificateurs ou des démodulateurs, etc. Les applications types sont celles de potentiomètres à réaction pour commandes de bord, commandes de machines-outils et l'étude de la suspension des véhicules.

L'élément se compose d'un arbre en acier inoxydable, tournant librement autour de son axe et glissant dans des paliers à friction réduite. L'arbre est fixé au porte-frotteurs à double contact entièrement métallique.

Les frotteurs en métal précieux fonctionnent sur les deux côtés d'un mandrin de précision et ils sont maintenus dans leur position exacte par des tiges de guidage en laiton rhodié ou en maillechort.

Le boîtier en aluminium anodisé et les plaques d'extrémité avec paliers articulés, à l'une des extrémités, complètent l'assemblage. L'emploi de paliers articulés permet la mesure sur plus d'un plan, comme pour les mouvements oscillatoires.

Ces potentiomètres sont prévus avec une longueur de course de 2,5 à 33cm dans une gammes de résistances allant jusqu'à 1MΩ.

EE 35 751 *pour plus amples renseignements*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

Crown House, Aldwych, London, W.C.2

LAMPES ET TUBES CATHODIQUES

La nouvelle gamme de lampes de grand rendement pour récepteurs télévision comprend le type 30C17, une triode-penthode à gain élevé et à grille-cadre qui constitue une des premières lampes à changement de fréquence conçues pour le fonctionnement anti-fading dans les blocs d'accord de télévision.

La 30F27 est également une nouvelle lampe à grand rendement à grille-cadre. C'est un amplificateur haute-fréquence à tétrodes à pente variable pour les blocs d'accord de télévision. Les avantages de cette lampe, par rapport à la double triode reliée en cascode, résident dans le nombre réduit des composants de circuit qui lui sont nécessaires et dans la disposition plus simple et parfois plus compacte qu'on peut réaliser.

Deux autres penthodes haute-fréquence à grille-cadre ont été conçues pour les étages moyenne fréquence des récepteurs de télévision, soit le type 6F24, à pente de 15 mA/V, avec un courant anodique de 10 mA, dont le rendement est excellent dans les récepteurs à courant alternatif ou à courant continu/courant alternatif, et le type 6F25, qui est une lampe à pente variable, pouvant recevoir des signaux d'entrée importants sans transmodulation. et constitue donc un amplificateur m.f. commun approprié.

Pour les circuits à deflexion verticale des récepteurs à tubes cathodiques de 110° ou 114°, la triode/tétrode à faisceau électronique dirigé de grande puissance et à courant de crête élevé, portant la référence 30PL14, permettra dans maints cas de réaliser des économies dans la construction des transformateurs de sortie. Le type 30P19 est un amplificateur de puissance à faisceau électronique pour les circuits de sortie à déflexion horizontale. Certaines caractéristiques de sa réalisation réduisent au minimum les dérangements de parasites pouvant apparaître dans l'image.

La diode U193 est une lampe efficace pour les étages de sortie de déflexion de ligne des tubes à rayons cathodiques de 110° et de 114°, et sa tension nominale de crête maxima de chauffage indirect est de 5,5 kV

On a pu voir également les nouveaux tubes cathodiques de 48,2 cm et de 58,4 cm, types CME1901 et CME2301 respectivement, qui sont maintenant incorporés à certains récepteurs. Ces tubes ont été réalisés afin d'améliorer la qualité de l'image et d'en assurer une, en même temps, qui soit rectangulaire à 95%. Ceci a pu être effectué grâce à une face de tube plus rectangulaire et un rayon de courbure plus étendu. Ces nouveaux tubes peuvent être comparés aux types précédents, à savoir le CME 1705 et le CME2104, de 43,1 et de 53,3 cm respectivement.

Des exemples de nouvelles réalisations dans les tubes de puissance Ediswan sont la triode de puissance présérie à refroidissement par la vapeur, Vapotron type V1503, conçue principalement pour l'amplification de commande par vibreur mais pouvant être utilisée aussi dans les applications de puissance haute-fréquence, la triode de puissance à refroidissement par air forcé, type 16J12, pour les transmissions, à laquelle on peut appliquer immédiatement la tension de filament complète, et, enfin, la triode type 14D13 à refroidissement par radiation, munie d'une base robuste en verre aggloméré, pour les amplificateurs-relais, les amplificateurs-vibreurs et les autres applications à basse et haute fréquence.

EE 35 752 *pour plus amples renseignements*

SYDNEY S. BIRD & SONS LTD

3 Palace Mansions, Palace Gardens, Enfield, Middlesex

BLOC D'ACCORD U.H.F.

(Illustration à la page 460)

Ce dispositif d'accord qui se compose d'un amplificateur HF à grille à la masse et d'un mélangeur auto-oscillateur a été conçu pour assurer l'accord continu dans la gamme de fréquences de 470 à 790 MHz, en utilisant des lignes de Lecher accordées par un condensateur à triple commande.

L'axe d'accord est couplé au condensateur d'accord au moyen d'un démultiplicateur 5:1 se trouvant à l'intérieur du bloc d'accord. La stabilité d'un dispositif d'accord aux ultra-hautes fréquences est d'importance primordiale. Cette stabilité peut être réalisée en utilisant un coffret en acier laminé extrêmement mince. Ce coffret est cloisonné par des tôles d'acier

afin de former les compartiments nécessaires d'entrée, d'accord et de sortie. La radiation oscillante est réduite au minimum par l'emploi d'une garniture formée d'une mince feuille de cuivre, comprimée par un tampon de caoutchouc et une enveloppe d'acier.

Le circuit d'entrée à bande étendue est formé d'une filtre π, afin d'assurer un équilibrage correct entre l'étage d'entrée à grille à la masse et l'antenne. D'autres connexions d'entrée peuvent être prévues pour des systèmes équilibrés ou déséquilibrés.

Un filtre passe-bande à accord continu assure une largeur de bande continue de 5 à 7 MHz sur toute la gamme d'accord. Le couplage entre les circuits accordés au primaire et au secondaire est réalise par des fentes dans la cloison de division. Le filtre passe-bande est couplé au mélangeur par un cadre à induction.

Un mélangeur auto-oscillateur à grille à la masse est utilisé, ce qui réduit au minimum la dérive de fréquence différentielle.

Le transformateur MF est relié au mélangeur au moyen d'un filtre afin de réduire le rayonnement d'énergie de l'oscillateur à travers la section MF. Le dispositif prévoit enfin le couplage par ligne au transformateur MF.

EE 35 753 *pour plus amples renseignements*

Dispositifs d'accord de perméabilité

(Illustration à la page 461)

Ces dispositifs compacts d'accord de perméabilité ont été étudiés pour l'utilisation, avec une puissance d'entrée capacitive, dans des postes de radio d'automobile et dans des récepteurs transistorisés portatifs ou analogues. L'assemblage se compose de bobines pour le signal de fréquence et de circuits oscillateurs dont l'inductance change avec les variations dans la position insérée de noyaux jumelés par la rotation d'un axe d'accord intégral.

Tous les dispositifs d'accord Cyldon RT8 sont préalignés avec précision pour le fonctionnement dans les circuits agréés. La seule opération d'alignement exigée dans le récepteur est le réglage des condensateurs d'équilibrage aux fréquences d'alignement définies.

Les dispositifs d'accord ne sont fournis, dans tous les cas, qu'avec les inductances de base variables, pour la bande onde moyenne et (ou) très haute fréquence/modulation de fréquence.

Notre gravure montre, de gauche à droite, un dispositif d'accord à deux bobines m.a. ou m.f., un dispositif à trois bobines m.a. et un dispositif combiné m.a./m.f.

EE 35 754 *pour plus amples renseignements*

G. & E. BRADLEY LTD

Electrical House, Neasden Lane, London, N.W.10

La société G. & E. Bradley Ltd. est une filiale des établissements Joseph Lucas (Electrical) Ltd. et s'occupe de la vente et des applications des semi-conducteurs produits par ces derniers.

Appareil de mesure des caractéristiques inverses de diodes

(Illustration à la page 461)

L'appareil de mesure des caractéristiques inverses de diodes fournit une indication visuelle de toute défaillance de tension inversée de crête et de la qualité des jonctions. La tension inversée de crête et le courant de fuite inverse sont effectivement mesurés par un instrument incorporé à l'ensemble. Les courants de fuite des transistors (Ico) peuvent également être déterminés aux tensions voulues en considérant la jonction collecteur/émetteur comme une diode avec émetteur et base court-circuités. Un interrupteur à quatre directions, fixé sur le panneau de l'appareil, fournit un choix de tensions d'essai allant de 250 à 1500V, tandis, qu'un autre interrupteur permet de lire quatre gammes de courant sur l'échelle de l'appareil.

EE 35 755 *pour plus amples renseignements*

Mémoire de données

(Illustration à la page 461)

La société G. & E. Bradley Ltd. a conçu et réalisé pour le Département de Physique Electronique de l'Université de Birmingham un appareil à mémoire de données pour le satellite Anglo-Américain qui doit être lancé dans le courant de l'année. Il sera utilisé par le susdit Département pour des expériences comportant la mesure des niveaux de densité d'électrons le long de la trajectoire orbitale du satellite.

Les indications sur la densité électronique maxima dans les premières dix secondes de chaque cycle de 61 secondes sont recueillies dans la mémoire et lues vers la fin de cet intervalle de temps, soit au dispositif télémétrique, aux fins de transmission immédiate, soit à une bande magnétique pour une transmission ultérieure à la terre, au moment voulu. La séquence des opérations comporte l'effacement, l'entrée, la lecture d'enregistrement, le stockage et la lecture de sortie, cette séquence se répétant toutes les 61 secondes et le minutage de chaque opération étant effectué par la minuterie principale du satellite.

La consommation électrique est très réduite, c'est à dire d'environ 0,6mW par mémoire au débit maximum, la tension provenant des systèmes à puissance solaire du satellite.

L'appareil est construit sous forme modulaire normale et contient six mémoires identiques.

Il est entièrement transistorisé et extrêmement compact, contenant 180 composants, principalement des transistors au silicium et des diodes, dans un espace de 3,17cm sur 13,3cm de diamètre. Il ne pèse que 226g. sans moulage.

Il a été conçu pour fonctionner avec une parfaite sécurité pendant la durée de vie prévue du satellite et également pour résister aux variations cycliques et aux températures extrêmes rencontrées dans l'espace.

EE 35 756 *pour plus amples renseignements*

BRAYHEAD LTD

Kennel Ride, Ascot, Berkshire

Transformateurs moyenne fréquence miniature

(Illustration à la page 461)

La société Brayhead Ltd vient de créer plusieurs nouvelles réalisations dans le domaine des transformateurs moyenne fréquence et des bobines oscillantes pour récepteurs radio à transistors. Afin de répondre à la demande des constructeurs des appareils de radio à usage personnel, la société Brayhead a commencé la production d'une gamme de pièces subminiature logées dans des boîtiers blindés de 7 mm de large sur 11 mm de haut. Ces transformateurs, qui sont à accord unique et dont le facteur de surtension est de 110, sont fournis avec bobinages s'adaptant à tous les types de transistors d'usage courant pour postes de radio ménagers.

Des transformateurs moyenne fréquence passe-bande sont également livrables, qui ont la propriété avantageuse de permettre le réglage des noyaux d'accord à partir du haut du boîtier, dont la base est de 24 mm × 12,5 mm × 19 mm de haut. Dans ce type de boîtier, le transformateur moyenne fréquence final comprend aussi la diode et le condensateur de filtrage, l'ensemble constituant une gamme de pièces des plus appropriées au récepteur de grandeur classique à grand rendement.

EE 35 757 *pour plus amples renseignements*

BRUSH CRYSTAL CO. LTD

Hythe, Southampton, Hampshire

Filtres en céramique

Ces éléments, faits en matière céramique piézoélectrique et appelés "Overtone Transfilter" (série T.O.) et "Fundamental Transfilter" (série T.F.), rendent superflu tout réglage initial ou ultérieur. Les Transfiltres T.O. sont des filtres en céramique avec des caractéristiques d'équilibrage d'impédances. Le disque piézoélectrique vibre au premier harmonique de son mode radial fondamental. Il forme un réseau à quatre bornes avec une entrée à impédance élevée et une sortie à impédance réduite. Avec un dessin de circuit approprié, le Transfiltre "Overtone" peut remplacer les éléments de transformation ou inductifs et capacitifs utilisés dans les circuits classiques à sélection de fréquence.

Le Transfiltre T.F. peut remplacer un condensateur de découplage émetteur. Ces composants améliorent la sélectivité et la sécurité de marche à long terme, et ils simplifient les circuits. Ils se prêtent aux circuits imprimés et peuvent être montés par des techniques d'assemblage automatiques.

Les composants ne sont pas affectés par l'humidité et assurent un bon comportement à température élevée.

EE 35 758 *pour plus amples renseignements*

RÉFÉRENCES DE TENSION

Le Statavolt Brush résulte de la demande fréquente de dispositifs de référence de tension s'appliquant à divers courants, diverses composantes résistives de l'impédance d'électrode et diverses temperatures.

Ce dispositif breveté se compose essentiellement d'un nombre de diodes montées en série et (ou) en parallèle avec les caractéristiques d'entrée et de sortie qui conviennent au réalisateur individuel.

Il a un robuste système de montage, convenant à la plupart des applications et il est fourni en un assemblage en alliage d'aluminium ou en matière plastique (nylon, mélamine ou chlorure de polyvinyle). L'assemblage en alliage d'aluminium agit comme source froide efficace pour permettre une dissipation accrue, tandis que l'élément à coffret en matière plastique permet des diodes en série à tension élevée, ainsi que l'isolement des éléments par rapport à d'autres composants.

Les applications types varient d'un niveau de référence de 1,1V à un coefficient de température zéro nominale, utilisé comme cellule étalon électronique, à un bloc d'alimentation stabilisée de 300V avec prises à 5V à un coefficient de température spécifié.

EE 35 759 *pour plus amples renseignements*

BURNDEPT LTD

Erith, Kent

COMMUTATEUR DE PROXIMITÉ

(Illustration à la page 462)

Le commutateur BE.2138 est un dispositif de proximité d'un coût réduit, stable et sensible, qui peut être employé pour le contrôle de niveau, le comptage, la mise en train de processus, etc.

Deux modèles à l'épreuve des pannes sont prévus pour le contrôle de niveau, à savoir le BE.2138 pour niveau réduit et le BE.238/HL pour niveau élevé, ce qui permet un contrôle sûr des poudres, fluides ou granules, conducteurs ou non-conducteurs. Le BE.238 a été étudié pour le fonctionnement continu dans des conditions industrielles défavorables et son fonctionnement n'est pas entravé par la poussière, l'humidité ou les vibrations. Une installation à l'épreuve du feu et des explosions peut être réalisée.

Le BE.238 est basé sur le fait qu'un oscillateur à commande par cristal a une valeur critique de capacité d'accord qui, lorsqu'elle est dépassée, provoque l'arrêt brusque de l'oscillation. La sonde sensible fait partie de cette capacité et toute capacité supplémentaire perçue par la sonde provoque l'arrêt de l'oscillateur, ce qui actionne un relais portant une jeu de contacts à permutation. Les contacts sont utilisés pour effectuer le contrôle voulu.

Un changement de capacité de 0,05pF peut être perçu. Des commandes préréglées, de réglage précis et approximatif, sont prévues, et la sensibilité peut être réglée sur ces commandes pour s'adapter à une utilisation particulière.

Le BE.238 peut percevoir, de façon sûre, 1000 articles par minute, en utilisant les contacts de relais pour commuter le circuit de commande. Pour des vitesses de perception plus élevées, on peut obtenir une impulsion qui alimente tout appareil électronique connexe.

Une gamme étendue de sondes sensibles normales est offerte et les sondes peuvent être étudiées en vue de besoins particuliers.

EE 35 760 *pour plus amples renseignements*

CONTRÔLEUR DE NIVEAU CONTINU

(Illustration à la page 462)

Le contrôleur de niveau continu, BE.291, fournit automatiquement l'indication du niveau de contenu de toute matière liquide, granulaire ou en poudre, à condition que ce niveau puisse être traduit en un changement de capacité électrique correspondante.

Dans une installation type, une sonde sensible est suspendue à la partie supérieure du réservoir ou de la trémie. Le contenu de celui-ci ou de celle-là est mis en contact avec la sonde et provoque un changement de capacité électrique proportionnel à la longueur de la sonde qui a été couverte. Le changement de capacité est traduit, au moyen d'un interrupteur de proximité, en un changement de courant correspondant, qui est reproduit sur un appareil de mesure à cadre mobile.

L'information sur le contenu du réservoir peut être répétée, à n'importe quelle distance raisonnable, à l'aide d'un appareil de mesure extérieur.

La distance entre la sonde sensible et le BE.291 est généralement limitée à 2^m, 133. Pour les câbles plus longs, une unité d'adaptation, BE.271, peut être utilisée.

Le BE.291 utilise un système d'échantillonnage continu électronique breveté. L'échantillonnage s'effectue sans l'aide d'aucune pièce mobile mécanique, n'utilisant qu'un interrupteur de proximité actionné par capacité. Le relais classique à induit, normalement utilisé dans un interrupteur de proximité, a été remplacé par un transistor. L'échantillonnage du contenu du réservoir s'effectue 50 fois par seconde, ce qui veut dire que le BE.291 peut répondre à des changements rapides de niveau. Le système est absolument sûr car toute panne du tube électronique ou du transistor arrête l'échantillonnage et, en pareil cas, l'appareil de mesure indique: "Réservoir Plein," quel que soit le niveau du réservoir.

EE 35 761 *pour plus amples renseignements*

APPAREIL DE MESURE DE PUISSANCE

(Illustration à la page 462)

Le BE.281 est un instrument portatif et compact pour la mesure de puissance jusqu'à 1,5W dans la gamme de fréquences de 1 kHz à 1000 MHz. Il est monté dans un coffret classique de format aviation.

L'appareil BE.281 est accordé avec précision à 50 ohms à l'aide d'une résistance de charge coaxiale, montée dans une cavité exponentielle. Cette résistance, qui est du type à carbone fixé sur céramique, est branchée à 5 ohms sur l'extrémité de terre et une diode au silicium est utilisée pour redresser le signal à ce point.

L'indication est fournie par un appareil de mesure d'une sensibilité de 50μA.

Trois échelles sont prévues, soit:

0 à 1,5W

0 à 300mW

0 à 100mW

de déviation totale. Les points étalonnés les plus bas sur les trois gammes sont à 50, 10 et 5mW respectivement.

Un tumbler à ressort est constamment polarisé sur la position de 1,5W protégeant ainsi les gammes plus sensibles. L'extrémité d'entrée comprend une douille de 50 ohms.

Une des principales caractéristiques du BE.281 est sa réponse rapide, ce qui constitue un contraste marqué avec les instruments de mesure de puissance plutôt lents du type bolomètre. Une réponse rapide signifie que l'appareil convient à la mesure de la puissance de sortie des émetteurs-radio tels que les radio-phares de secours air/mer à impulsions et n'importe quels niveaux réduits de puissance modulée dans la bande très hautes fréquences/ultra-hautes fréquences.

EE 35 762 *pour plus amples renseignements*

ELECTRO ACOUSTIC INDUSTRIES LTD

Stamford Works, Broad Lane, Tottenham, London, N.15

HAUT-PARLEURS MINIATURE

(Illustration à la page 462)

Une série de haut-parleurs miniature, destinés principalement à l'emploi dans des récepteurs à transistors portatifs, a été créée par la susdite société. Elle comprend quatre haut-parleurs aux diamètres de 5,08 cm, 5,67 cm, 7,62 cm et 8,57 cm. Tous ces haut-parleurs sont d'une grande efficacité acoustique et la réponse de fréquence moyenne des deux grands modèles est de 200 Hz à 5 kHz et de 150 Hz à 7 kHz respectivement.

EE 35 763 *pour plus amples renseignements*

ELLIOTT-AUTOMATION LTD

34 Portland Place, London, W.1

CONNECTEUR DIRECTIONNEL COAXIAL VARIABLE

(Illustration à la page 463)

Cet instrument prototype, produit par la Division Radar de la Société Elliott Bros. (London) Ltd. est basé sur l'effet de réaction entre deux lignes coaxiales adjacentes, avec une fente dans le mur commun. La variation des positions relatives des conducteurs intérieurs de forme spéciale, commande la quantité d'énergie transmise de la ligne principale de transmission à la ligne auxiliaire. La puissance couplée peut être modifiée légèrement de —6dB à —40dB au-dessous de celle de la ligne principale. L'indication du

couplage est donnée par une échelle de lecture numérique fixée à l'axe d'entraînement, la précision de l'étalonnage étant de ±0,1dB. Dans une gamme de fréquences d'une octave, la variation de couplage maximum, pour n'importe quel réglage, est inférieure à 2dB.

Pour la paire de connecteurs inutilisés, correctement terminés par des charges équilibrées (qui peuvent être incorporées au dispositif), le rapport d'onde stationnaire de la tension d'entrée est inférieur à 1,3 (0,77) au couplage maximum, et il est inférieur à 1,2 (0,83) à tous les autres réglages. Le mode présenté actuellement couvre les gammes de 600 à 1200 MHz; ses capacités de puissance sont de 10W en moyenne et de 10kW comme valeur de crête.

EE 35 764 *pour plus amples renseignements*

Amplificateurs correcteurs et de moteur de couple

(Illustration à la page 463)

Les amplificateurs transistorisés correcteurs et de couple que produit la société Elliott sont prévus pour l'utilisation à des températures pouvant atteindre 100°C. Ils sont particulièrement indiqués pour l'emploi en liaison avec la série des moteurs de couple Elliott mais peuvent être utilisés également avec d'autres types, à condition qu'il y ait l'impédance voulue.

L'étage de puissance est à gain variable et dérive réduite. La réponse de fréquence de l'amplificateur et du moteur de couple accuse un retard de phase de 90° à plus de 200Hz.

L'amplificateur correcteur est un appareil d'une grande souplesse d'emploi avec un gain de circuit ouvert de 16V/μA. Cet amplificateur a également un rendement à dérive réduite.

EE 35 765 *pour plus amples renseignements*

Tetes d'enregistrement magnétiques

(Illustration à la page 463)

Les têtes à faces métalliques et à noyau de ferrite utilisées dans le système d'enregistrement magnétique d'instrumentation Elliott sont fournies maintenant comme éléments à fiches individuels.

Ces têtes d'enregistrement conviennent aux systèmes d'enregistrement numérique ou analogique, utilisant n'importe laquelle des formes classiques de modulation. La combinaison de noyaux de ferrite et de largeurs fort réduites permet l'enregistrement et la reproduction de fréquences à 4 kHz par 2,5cm de vitesse de bande.

Des têtes classiques sont produites selon les spécifications britanniques (S.B.A.C.) ou américaines (I.R.I.G.) et portant 16 ou 14 pistes par 2,5cm, en ligne ou feuilletées. Il existe une variété de montages de pistes pour bandes de 0,635cm 1.27cm ou 2.54cm.

Le mode de construction breveté assure un excellent alignement azimutal entre les pistes et élimine le besoin onéreux de remplacements de têtes. Lorsque l'usure d'une tête se produit, il n'y a qu'à remplacer la face polaire pour obtenir à nouveau un rendement parfait.

L'espace entre les pistes est de 1,5 ou de 3mm en ligne et de 1,8mm feuilleté, tandis que la largeur de piste est de 0,85 ou de 1,9mm feuilleté. La largeur d'entrefer est de 3 à 5μ. L'inductance de la tête d'enregistrement est de 0,5mH et celle de la tête de réenregistrement de 10 à 15mH.

EE 35 766 *pour plus amples renseignements*

Système logique transistorisé

(Illustration à la page 463)

Panellit Limited, un membre du Groupe Elliott-Automation, a exposé une nouvelle version entièrement sous moulage du système logique transistorisé MINILOG, constitué de corps solides, pour les opérations industrielles à séquences contrôlées.

Le MINILOG peut être appliqué tant à des systèmes logiques simples qu'à des systèmes complexes. Il a été conçu pour remplacer les relais, les commutateurs à gradins et autres dispositifs semblables, en augmentant tant la vitesse que la sécurité du fonctionnement. Il est entièrement constitué de corps solides, ne nécessite aucun entretien et assure un service sans défaut dans les conditions ambiantes les moins favorables.

Il existe deux types d'éléments MINILOG. L'un est à six entrées donnant une fonction "inverse et", et une puissance de sortie pouvant entraîner jusqu'à cinq entrées; l'autre incorpore un émetteur-palpeur et sa puissance de débit peut entraîner jusqu'à vingt cinq entrées. Les deux types sont exactement de la même grandeur (50,8 × 21,6 × 16mm) et l'espace qu'ils occupent ne dépasse guère 16,387 cm3. Ils sont munis de onze conducteurs à fils de cuivre étamé de 0,8mm de diamètre. Des éléments de puissance à transistors peuvent être fournis comme excitateurs d'extrémité supérieure et inférieure pour actionner des solénoïdes et d'autres dispositifs similaires jusqu'à un maximum de 50V 1A.

Quarante huit éléments "MINILOG" peuvent être montés sur une plaquette en papier assemblé à la résine synthétique mesurant 25,4cm sur 43,1cm. Un châssis spécial "MINILOG" avec fiches et prises dorées pour fournir des connexions inter-plaquettes, de signaux et de puissance, peut recevoir jusqu'à douze de ces plaquettes.

EE 35 767 *pour plus amples renseignements*

ENTHOVEN SOLDERS LTD

Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16

Préformes de transistors de puissance

Ces préformes ont été conçues afin d'assurer un contact étroit entre le transistor de puissance et sa source froide et de garantir ainsi une transmission maximum de chaleur.

Lorsque la base du transistor est en matière moulée, les imperfections superficielles créent des entrefers entre la base du transistor et l'appareil sur lequel il est fixé. Le même inconvénient s'applique, dans une mesure un peu moindre, aux bases usinées. Dans les deux cas donc, la transmission de chaleur est loin d'être parfaite.

L'emploi d'une préforme de transistor de puissance Enthoven entre les deux faces métalliques comble tout espace de jeu créé par les surfaces imparfaites, donnant un contact à 100% et garantissant une transmission de chaleur efficace de la base du transistor. Les préformes peuvent être fabriquées en plusieurs autres matières qui donnent également de bons résultats mais, en raison de leur nature corrosive en certains cas, elles ne peuvent être utilisées pour des besoins militaires. Des transistors de puissance avec une base elliptique, c'est à dire du type dont il est question, sont actuellement produits dans plusieurs pays et se conforment à une spécification commune de façon à répondre sans difficulté aux conditions d'emploi réglementaires des armes de ces pays. Le préforme Enthoven devrait donc donner des résultats uniformes dans des températures d'emploi allant jusqu'à 50°C.

EE 35 768 *pour plus amples renseignements*

ERIE RESISTOR LTD

1 Heddon Street, London, W.1

Condensateurs céramique miniature

Le condensateur céramique Transcap Style T est une pièce miniature à capacité élevée et du type à disque, étudiée pour le couplage à tension réduite ou pour le découplage dans les circuits transistorisés. Il a un diamètre de 15,1 mm et son épaisseur est de 4mm. Sa capacité est de 0,5μF et il fonctionne à 3V c.c. Le facteur de puissance est de 5% mesuré à 1 kHz. D'autres valeurs de capacité et tensions de service seront introduites prochainement.

Les condensateurs céramique styles Y et Z sont des éléments tubulaires subminiature conçus principalement pour être incorporés aux transformateurs moyenne fréquence. Ils ont, tous deux, un diamètre de 2,5mm. Le style Y a 5,6mm de long et le style Z a 7,6mm. La gamme de capacités du premier va de 150 à 200pF et celle du second va de 201 à 300 pF. La tension de service des deux types est de 150V et le facteur de puissance est de 0,2%.

Le condensateur miniature de traversée "Discoidal" a une capacité de 1000 pF et une tension d'utilisation de 350V c.c.

La forme compacte du condensateur de traversée "Discoidal" permet au courant de s'étendre en éventail sur une surface de 360° à partir de l'électrode centrale, donnant le parcours électrique le plus court possible entre la borne centrale et le châssis. L'inductance série interne est ainsi réduite au minimum. Des bornes relativement courtes et lourdes assurent une inductance exté-

rieure minima, toujours reliée aux condensateurs. Ces caractéristiques rendent le Discoidal convenable pour toutes les applications à très hautes fréquences et ultra-hautes fréquences. Il peut être hermétiquement scellé afin de lui donner la rigidité mécanique et la résistance au climat tropical.

EE 35 769 *pour plus amples renseignements*

FORTIPHONE LTD

92 Middlesex Street, London, E.1

RELAIS MINIATURE

(Illustration à la page 464)

Ce relais, type G.100, a été mis au point pour le Ministère de l'Aviation pour servir d'élément de qualité spéciale pour les engins téléguidés.

Une réalisation à induit équilibré est utilisée, et, afin de réduire la contamination par contact, des contacts en alliage d'or sont utilisés tandis que les bobines et les contacts sont scellés dans des compartiments séparés.

Les relais type G.100 fonctionnent dans une gamme de températures de −55°C à + 125°C et peuvent soutenir des accélérations allant jusqu'à 100g. Les caractéristiques nominales de contact sont de 0,3A à 50V c.c. et des bobines de fonctionnement peuvent être fournies pour des tensions de 1,5 à 48V. Le temps de fonctionnement/déclenchement est inférieur à 15 msec et les résistances de contact sont inférieures à 40 mΩ (à 10mV).

Il existe des versions à commutation bipolaire et quadripolaire. Les premières mesurent 20,3 × 22,9 × 9,4 mm et les autres 20,3 × 22,9 × 17,8 mm.

EE 35 770 *pour plus amples renseignements*

GOODMANS INDUSTRIES LTD

Axiom Works, Wembley, Middlesex

HAUT-PARLEURS SUB-MINIATURE

(Illustration à la page 464)

Une nouvelle gamme de haut-parleurs subminiature est offerte à la vente par cette société. Ils sont à châssis plat et munis de petits assemblages à aimants qui ne produisent qu'un minimum de parasites.

La gamme comporte cinq dimensions, a savoir:

5,08cm 5,71cm 6,35cm 6,98cm et 7,62cm. Il y a, en outre, trois grandeurs d'aimants pour chaque modèle. Enfin, la gamme est doublée par l'existence de versions inverses par rapport aux précédentes. Elles ont toutes des impédances allant de 3 à 80Ω et elles sont munies de systèmes à aimants d'une très haute efficacité.

EE 35 771 *pour plus amples renseignements*

HUGHES INTERNATIONAL (U.K.) LTD

Glenrothes, Fife, Scotland

DIODES DE COMMUTATION

La série des diodes de commutation fabriquées dans cette nouvelle usine écossaise comprend une série de diodes à pointe de contact au germanium, prévues en premier lieu pour les applications industrielles où les caractéristiques spéciales des diodes à pointe de contact comme, par exemple, leur très bonne réponse transitoire et leur capacité réduite, sont de grande valeur. La gamme au germanium est complétée par une série de diodes à agglomérant d'or, ayant une très bonne conductance et une réponse transitoire également bonne.

La gamme des diodes au silicium comprend la série des diodes universelles HS10, pouvant être utilisées comme petits redresseurs ou pour la commutation à des taux allant jusqu'à 100kHz. La nouvelle diode HS.1020 de 200V qui vient d'être ajoutée à cette série et dont le rapport de résistance inverse garanti est de 5×10^6 dans des conditions normales, constitue un apport du plus haut intérêt. La série des diodes de calculateur HS.11 complète cette gamme, fournissant une excellente réponse transitoire (charge accumulée caractéristique: 700 pico coulombs) ainsi qu'une tension nominale inverse élevée et une fuite inverse réduite.

EE 35 772 *pour plus amples renseignements*

JAMES A. JOBLING & CO. LTD

Wear Glass Works, Sunderland

RÉSISTANCES À FILM À OXYDE MÉTALLIQUE

Une nouvelle gamme de résistances à film à oxyde métallique vient d'être présentée sous la désignation de style "CJ." Cette gamme comprend le CJ.20, qui est un type entièrement isolé à 0,5W, d'une longueur de 9,5mm et d'un diamètre de 3,8mm, et le CJ32, qui est une résistance de 1W, pleinement isolée, dont la longueur est de 12,7mm et le diamètre de 5,1mm. Il y a, en outre, une résistance de 2W qui est produite depuis quelque temps et qui sera maintenant le type CJ.42.

Ces résistances sont principalement destinées à l'utilisation dans les calculateurs et appareils analogues.

EE 35 773 *pour plus amples renseignements*

THE M.O. VALVE CO. LTD

Brook Green, Hammersmith, London, W.6

LAMPES ET TUBES CATHODIQUES

Le tube TWC5 est le dernier-né de la série des tubes à ondes progressives à focalisation périodique en cours de production à Hammersmith. Il s'agit effectivement d'un amplificateur de puissance à tube à ondes progressives, susceptible de fournir 11W dans la bande de 5,8 à 8,2 kMHz, et prévu pour assurer un rapport d'amplitude de tension d'entrée et de sortie "à froid" inférieur à 2:1. Il a été spécialement réalisé pour les systèmes de télécommunications multicanaux et il a une sortie de puissance maxima de 15W dans la bande de 5925 à 6425 MHz. L'équilibrage est supérieur à 1,4 dans la largeur de bande la plus étroite. Des résultats analogues peuvent être obtenus dans d'autres bandes étroites.

Le LD603 est un nouveau tube cathodique de 12,7cm à post-accélération de grande efficacité, assurant une sensibilité de déviation élevée. Il est actuellement prêt à la production à Hammersmith. Sa sensibilité de déviation dans la direction X est de 9,5V/cm et dans la direction Y de 3,7V/cm. Une nouvelle forme de post-accélération a été employée dans ce tube afin de produire trois fois la sensibilité de déviation des tubes de post-accélération helicoïdaux, tout en maintenant une zone balayée de 10cm × 6cm.

EE 35 774 *pour plus amples renseignements*

MINIATURE ELECTRONIC COMPONENTS LTD

The Lye, St. John's, Woking, Surrey

POTENTIOMÈTRES ET RÉSISTANCES MINIATURE

(Illustration à la page 464)

La série des potentiomètres d'écrêtage multitours M.E.C. a été augmentée et comprend maintenant un modèle à circuit imprimé. Des modèles doubles et triples sont offerts dont la construction intégrée permet de gagner de la place en les installant. Tous les types sont présentement fournis avec un embrayage glissant, en variante aux arrêts d'extrémité positifs. Ces potentiomètres miniature sont logés dans des coffrets monoblocs en aluminium anodisé et munis de cosses à souder ou de câbles souples. Dix-sept valeurs normales sont prévues de 10Ω à 125 kΩ, fonctionnant dans une gamme de températures de 55° à + 150°C et absorbant 2,75 W à 50°C.

Une nouvelle gamme de 15 types de résistances bobinées de précision comprend cinq modèles miniature dont trois ont été spécialement étudiés pour les applications à circuits imprimés.

Une nouvelle réalisation M.E.C. est d'un intérêt tout particulier. Il s'agit d'un tumbler dont le diamètre n'est que de 0,635 cm et la longueur de 1,27 cm. Malgré ses dimensions minuscules, son régime nominal est de 1 A à 50 volts c.c.

EE 35 775 *pour plus amples renseignements*

MORGANITE RESISTORS LTD

Bede Trading Estate, Jarrow, Co. Durham

POTENTIOMÈTRE MINIATURE

(Illustration à la page 465)

Le nouveau potentiomètre miniature, type 56, que vient de présenter la société Morganite Resistors Ltd. sera d'un intérêt particulier pour les réalisateurs de petits récepteurs transistorisés. Son diamètre total n'est que de 20,3mm et les cosses de circuit imprimé fournissent un moyen pratique de montage.

L'utilisation d'un élément a résistance éprouvée avec un nouveau genre de contact donne un bruit de rotation réduit, malgré ses petites dimensions. Il est

muni d'un interrupteur unipolaire de construction solide.

Sa valeur nominale est de 0,25W à 20°C et sa résistance d'extrémité maximum dans le sens inverse des aiguilles d'une montre est de 1Ω. L'interrupteur a une capacité nominale de 50V, 250mA (maximum) et sa résistance de contact est de 0,02Ω (jusqu'à 0,05Ω après 10 000 opérations à pleine charge).

EE 35 776 *pour plus amples renseignements*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

CONDENSATEURS AU TANTALE SUB-MINIATURE

(Illustration à la page 465)

Il s'agit ici d'une nouvelle gamme de condensateurs électrolytiques au tantale sub-miniature, convenant aux équipements transistorisés.

La diélectrique pentoxyde au tantale, formée à l'intérieur du condensateur, est beaucoup plus mince et peut résister à une tension plus élevée que celle à l'oxyde d'aluminium. On obtient donc un produit à capacité-tension accrue, résultant en des dimensions beaucoup plus réduites.

La gamme comprend 10 types, gradués selon leurs caractéristiques de tension et de capacité en bacs de trois différentes dimensions.

Le plus petit bac ne mesure que 2mm × 5mm et loge un condensateur de 0,64μF 25V de valeur de travail ou, par exemple, un condensateur de 1,6μF 10V de valeur de travail. A l'autre extrémité de l'échelle, des condensateurs dont la puissance de travail atteint 40μF 2,5V ou 16μF, 6,4V sont dans des bacs ne mesurant que 3mm × 8,9mm.

Leurs dimensions très réduites rendent ces nouveaux condensateurs particulièrement indiqués comme amplificateurs pour sourds, récepteurs particuliers, etc. exigeant le moins d'espace possible. En raison de leur résistance aux chocs et aux vibrations, et de leur faculté de pouvoir travailler de façon satisfaisante à de très faibles pressions atmosphériques, ces condensateurs peuvent être utilisés avec succès dans le matériel de bord.

La température normale maximum est de 55°C, mais 60°C sont admissibles pour un fonctionnement de 12 heures dans n'importe quelle période de 24 heures. Si la température ne dépasse pas 30°C la tension de régime peut être accrue de 10%.

Les nouveaux condensateurs sont enfermés dans des boîtes tubulaires d'argent, hermétiquement scellées et isolées extérieurement par un revêtement de matière plastique.

EE 35 777 *pour plus amples renseignements*

CONDENSATEUR VARIABLE À DIÉLECTRIQUE SOLIDE

Ce condensateur jumelé à diélectrique solide est un nouveau dispositif miniature conçu pour accorder les postes de radio de poche.

Les deux sections ont des capacités de 0 à 180pF (accord d'antenne) et de 0 à 80pF (accord de l'oscillateur local). Chaque section comprend un trimmer de 0 à 6pF.

Le nouveau condensateur se distingue par les particularités suivantes: ailettes de stator et de rotor en laiton, alignées avec précision; diélectrique plastique à perte réduite; absence de microphonie; stabilité électrique élevée et solidité mécanique. Le condensateur est logé dans une enveloppe à l'épreuve de la poussière, en résine synthétique, ne mesurant que 20mm de long sur 15mm de large. Le montage se fait sur deux ouvertures à prises, sur la même surface que l'axe, les ouvertures étant placées de manière à s'aligner avec la plaquette de circuit imprimé classique de 25mm. Les broches terminales sont en saillie vers le bas, ce qui permet de souder le condensateur directement sur un circuit imprimé.

EE 35 778 *pour plus amples renseignements*

TRIMMER À DIÉLECTRIQUE SOLIDE

(Illustration à la page 465)

Ce nouveau trimmer à diélectrique solide assure des variations de capacité de grandeur suffisante, tout en dépassant à peine en hauteur la surface d'une plaquette de circuit imprimé.

La gamme de capacités va de 1,5pF à 60pF avec une capacité de réglage supérieure à ±0,12pF, et la tension de régime maxima est de 300V c.c. La hauteur assise du trimmer est de 8mm et sa surface maxima est de 14 × 14mm.

Le trimmer est logé dans un coffret anti-poussières en résine synthétique claire, dont la forme est telle qu'elle recouvre l'extrémité de l'axe afin d'empêcher tout glissement latéral du tournevis durant le réglage. Trois broches terminales, espacées l'une de l'autre de manière à s'adapter à la plaquette de circuit imprimé classique de 25mm, sont en saillie vers le bas, permettant ainsi le soudage direct sur un circuit imprimé.

Les dimensions réduites du trimmer le rendent propre à un grand nombre d'applications dans le matériel à transistors.

EE 35 779 *pour plus amples renseignements*

CIRCUITS HYBRIDES ET MÉLANGEURS ÉQUILIBRÉS

La société Mullard Equipment Limited a réalisé une nouvelle série de mélangeurs équilibrés coaxiaux et d'hybrides coaxiaux pour l'emploi dans des récepteurs microondes à des fréquences de 1,0 Gc/s à 11,50 Gc/s.

Les caractéristiques les plus marquantes de ces nouveaux composants microondes sont l'étendue des fréquences qu'ils couvrent sans accord, et leurs dimensions très réduites par rapport à leurs équivalents de guides d'ondes. Ils sont, donc, particulièrement indiqués pour l'emploi dans des circuits récepteurs non accordés.

Tant les hybrides que les mélangeurs sont basés sur des circuits hybrides à inversion de phase d'une nouvelle conception, capables de fonctionner sans accord aucun dans la gamme de fréquences de 3:1. Le mélangeur equilibré s'obtient en insérant dans l'hybride des cristaux mélangeurs appropriés et des circuits d'équilibrage connexes.

Le nouveau circuit hybride est un perfectionnement du circuit en anneau classique dont on a remplacé une longueur de ligne par un circuit à inversion de phase, le rendement de ce dernier étant indépendant dans une très grande mesure de la fréquence. En dehors du fait qu'il élimine une longueur électrique sensible à la fréquence, ce dispositif transforme également le circuit classique en une structure symétrique à quatre bornes, donnant un degré élevé de stabilité dans une gamme étendue de fréquences.

La série complète comprend cinq mélangeurs et cinq hybrides qui couvrent dans leur ensemble les bandes L1, L2, S, C et X. Ils sont munis de connecteurs coaxiaux normaux, type C ou type N. Des extrémités pour guides d'ondes peuvent être fournies sur demande.

EE 35 780 *pour plus amples renseignements*

CONDENSATEURS ÉLECTROLYTIQUES MINIATURE

(Illustration à la page 465)

La gamme des condensateurs électrolytiques miniature Mullard comprenait jusqu'ici 22 types couvrant des capacités allant de 0,8 μF à 200 μF et des tensions de régime de 4V à 25V.

Dix-huit nouveaux types ont maintenant été ajoutés aux précédents, ce qui porte la gamme des capacités disponibles à 640 μF et la tension de travail maximum à 64V c.c.

Les condensateurs sont classés selon leur capacité et leur tension de régime en boîtes de cinq formats différents. Le plus petit format (10mm × 3mm) contient, par exemple, des condensateurs de 0,8 μF 25V c.c. de service ou 4 μF 4V c.c. de service. Le plus grand format (9mm × 5,1mm) loge des condensateurs pouvant atteindre 640μF 2,5V c.c. de service ou 32 μF 64V c.c. de service.

Les condensateurs dans les trois plus grands formats de boîtes sont spécialement modifiés pour montage sur circuit imprimé. Ils sont fournis avec base en matière plastique jaune d'où émergent des fils de connexion pouvant être soudés directement à la plaquette.

EE 35 781 *pour plus amples renseignements*

CONDENSATEURS D'ÉQUILIBRAGE EN CÉRAMIQUE

(Illustration à la page 466)

Cette nouvelle gamme de petits trim-

mers de qualité supérieure a été prévue pour le matériel de transmissions professionnel.

Elle comprend trois types dont les capacités sont de 0,7 pF à 3,7 pF, de 0,8 pF à 6,8 pF et de 0,9 pF à 12,9 pF respectivement. Les trois types ont une diélectrique en céramique et sont prévus pour une tension nominale de 400 V c.c. Ils sont tropicalisés et propres à l'utilisation dans une gamme de températures de −50°C à +100°C.

Les nouveaux trimmers sont de forme tubulaire, leur diamètre extérieur étant de 5,9 mm et leur hauteur de 9,9 mm ou de 13 mm ou encore de 14,6 mm, selon la capacité. Leur queue filetée permet la fixation à une seule ouverture tandis que leur noyau mobile torsadé est fendu aux deux extrémités, de façon à ce que le trimmer puisse être réglé au-dessous ou au-dessus du châssis.

EE 35 782 *pour plus amples renseignements*

R. B. PULLIN & CO. LTD

Phoenix Works, Gt. West Road, Brentford, Middlesex

AMPLIFICATEURS À TRANSISTORS

(Illustration à la page 466)

L'amplificateur type TA.IG utilise des transistors du type le plus récent et il a été conçu pour le fonctionnement des servomoteurs format 10 ou des convertisseurs. Il engendre une puissance de sortie de 4W lorsqu'on l'emploie dans une température ambiante de +55°C et il fournit 6W à des températures inférieures à 50°C.

L'amplificateur TA.IG a été principalement prévu pour le fonctionnement sur alimentation de 26V 400Hz, mais il peut être entraîné, en variante, par une tension en continu de 18V.

L'amplificateur type TA.3 (voir notre gravure) a été étudié pour fournir la puissance de phase de commande des servo-moteurs, jusques et y compris la taille 15, mais on peut également l'utiliser pour d'autres applications lorsqu'on travaille à l'aide d'un transformateur extérieur à prise médiane. Il donne une puissance de sortie de 7W dans une gamme de températures ambiantes allant de −40°C à +70°C lorsqu'on travaille sur alimentation de 13-0-13V 400Hz. La caractéristique d'entrée est telle qu'un signal d'entrée de 150mV produit une sortie de 4W.

EE 35 783 *pour plus amples renseignements*

SEALECTRO CORPORATION

Hersham Factory Estate, Walton-on-Thames, Surrey

PLAQUETTES DE PROGRAMMATION

(Illustration à la page 466)

Le système de programmation à usages multiples Sealectoboard est livré sous diverses formes. Le principe du "Sealectoboard" consiste en une rangée de contacts plats en cuivre de béryllium montés en plans superposés à angles droits par rapport l'un à l'autre. La programmation s'effectue en insérant des ergots de court-circuit. N'importe quel nombre de douilles peut être inclus selon la spécification exigée. Une fiche coaxiale est également fournie, dont le corps peut contenir une diode ou un autre composant, lui donnant ainsi une faculté numérique ou de substitution. Un perfectionnement récent est représenté par une douille individuelle qui constitue un complément au type normal de douilles de câblage et donne une plus grande souplesse encore au système. Quoique conçu comme système de programmation sans fils, des fiches sont fournies pour le câblage sous forme de cordons de renvoi ordinaires de plaquettes à plaque unique.

EE 35 784 *pour plus amples renseignements*

TELEQUIPMENT LTD

313 Chase Road, Southgate, London, N.14

OSCILLOSCOPE DE MESURE

(Illustration à la page 466)

L'oscilloscope S.42 a été réalisé principalement pour les applications exigeant de grandes vitesses d'enregistrement à des taux de répétition réduits. Son tube cathodique de post-accélération en spirale de 10,16 cm permet de voir et de photographier une impulsion unique de 1 µsec. L'amplificateur Y a une largeur de bande qui va du courant continu à 500 kHz sur grand gain et du courant continu à 6 MHz sur gain réduit, la sensibilité maxima de la première étant de 10 mV/cm et de 100 mV/cm pour la dernière. Un affaiblisseur à entrée étalonnée donne la lecture directe des tensions d'entrée en continu ou en alternatif de 10 mV/cm à 50 V/cm. La base de temps est étalonnée à 18 vitesses de balayage préréglées, de 1 µsec/cm à 500 msec/cm. Une commande d'étalement X assure un étalement à variation continue jusqu'à 10 diamètres d'écran. Le déclenchement peut être automatique ou sélectif, ce qui permet de déclencher la base de temps de n'importe quel point voulu de la forme d'onde d'entrée.

EE 35 785 *pour plus amples renseignements*

PRÉAMPLIFICATEUR À DEUX CANAUX

(Illustration à la page 466)

Le préamplificateur PA2 a été réalisé pour des applications nécessitant une grande sensibilité comme celles de la médecine, de la biologie et de l'électromécanique. Il a deux amplificateurs indépendants d'un degré élevé de séparation, chacun d'eux utilisant deux penthodes en cascade avec sortie à charge cathodique. L'alimentation est également indépendante, tandis qu'une haute tension stabilisée garantit une stabilité parfaite d'amplification.

Quoique principalement réalisé pour être utilisé avec le "Serviscope" à double faisceau, le PA2 peut en fait être employé avec n'importe quel oscilloscope de la série Telequipment pour donner une sensibilité étalonnée maxima de 1 mV/cm. Le niveau de bruit et de bourdonnement étant extrêmement bas, le PA2 peut être utilisé avec le type S42 ou S42A pour donner une sensibilité maxima de 100 µV/cm.

EE 35 786 *pour plus amples renseignements*

Résumés des Principaux Articles

Radar de veille secondaire par D. H. R. Archer

Résumé de l'article aux pages 414 à 420

L'auteur examine dans cet article les principes et les caracteristiques fondamentales du radar secondaire et énonce certains des problèmes de leur réalisation. Après avoir traité en détail de différentes méthodes de suppression de l'interrogation du lobe latéral, il étudie l'emploi du dispositif comme chaînon de voie de transmission d'informations, ainsi que les possibilités d'un développement du système et l'orientation future qu'il pourrait recevoir.

Un orgue simple à cordes électroniques par J. Venn

Résumé de l'article aux pages 421 à 425

L'auteur traite du concept d'un instrument de musique electronique prévu pour obvier aux difficultiés qu'éprouve tout débutant apprenant à jouer un instrument de musique du type à clavier. Il décrit un instrument avec lequel on peut produire des cordes à quatre notes à n'importe quel ton voulu, sur pression d'un seul bouton, et il discute de l'extension de ce système à un clavier mélodique.

Après avoir donné des détails généraux d'une méthode pour la production de cordes à quatre notes avec "sixièmes" et "septièmes" supplémentaires, à n'importe quel ton majeur ou mineur, par l'emploi d'un jeu d'oscillateurs "suivis", il décrit un instrument simple comportant un générateur monophonique à trois octaves commandé à partir du clavier et s'inspirant de la susdite méthode. Il complète cette description par certains détails des oscillateurs mélodiques et à cordes, diviseurs d'octaves, étages d'accord, amplificateurs et blocs d'alimentation. Il semble qu'une version expérimentale de cet instrument ait donné des résultats satisfaisants.

Le silicium dans les dispositifs à étages en tant que générateurs d'impulsions de grande puissance par R. P. F. Lauder

Résumé de l'article aux pages 426 à 431

Plusieurs circuits sont présentés afin de montrer que les dispositifs P.N.P.N. à deux ou à trois bornes peuvent être utilisés comme générateurs d'impulsions fournissant des impulsions de puissance parfaitement rectangulaires pour une variété d'usages comprenant, entre autres, les émetteurs dans la zone de puissance d'entrée de crête de 20kw.

Un analyseur de répartition de probabilité à mémoire électrostatique par I. K. Harvey

Résumé de l'article aux pages 432 à 436

L'auteur décrit un instrument qui fournit, au moyen de techniques électroniques, une distribution de probabilité unidimensionelle de n'importe quelle variable électrique.

Les méthodes numériques binaires sont utilisées et les informations reçues sont stockées dans une mémoire électrostatique d'une contenance de 960 chiffres.

La gamme d'amplitudes d'intérêt est divisée en 64 voies ayant chacune une capacité de 15 chiffres (32767 coups par voie).

Une linéarité de $\pm 0{,}25\%$ peut être obtenue et des formes d'onde d'entrée allant de zéro à une limite supérieure de fréquence de 20 kHz/sec peuvent être analysées.

Un amplificateur de courant continu à glissement réduit par D. J. Collins

Résumé de l'article aux pages 437 à 441

On exige un degré de précision de plus en plus élevé de la part des instruments d'usine. L'un des facteurs qui influent sur la précision globale des installations à courant continu de niveau réduit est l'efficacité de l'amplificateur. La nécessite de pouvoir s'appuyer sur un amplificateur convenant à des degrés de précision de 0,1% de l'échelle totale, a conduit à la réalisation de l'amplificateur décrit dans cet article. Le choix de la configuration, le montage des circuits et les paramètres de tenue sont aussi analysés. Un glissement d'entrée équivalent inférieur à 24μV a pu être obtenu avec cet appareil qui est offert dans le commerce.

La théorie des amplificateurs de tension à contre réaction par C. H. Vincent

Résumé de l'article aux pages 442 à 444

Une légère modification a été apportée à la méthode courante d'analyse des amplificateurs de tension à contre réaction. Cette modification implique la reconnaissance du fait que la tension de réaction atténuée ne peut toujours, en pratique, être soustraite directement de la tension de borne d'entrée, comme on l'assume communément en théorie, car une forme quelconque de circuit mélangeur doit être employé habituellement. Une fois reconnu ce fait, il devient plus facile d'appliquer l'analyse générale à un circuit particulier sans traitement spécial.

Un compteur de cellules sanguines par G. P. Burn et P. J. Tosh

Résumé de l'article aux pages 444 à 445

Cet article décrit la méthode de Coulter pour compter les cellules de sang. L'appareil dont il est question permet de compter 10 000 cellules en une minute environ à l'aide de Dékatrons. La technique est simple et sûre.

Un coffret à transistors à température constante par M. W. Rignall

Résumé de l'article aux pages 452 à 453

Le coffret dont il s'agit ici peut loger douze transistors du format OC201. Il se compose d'un bloc d'aluminium, employant un OC29 comme élément de chauffage et une thermistance comme élément sensible à la température. Cette dernière peut être maintenue à n'importe quelle valeur voulue dans la gamme de 35 à 55°C, avec une constance supérieure à 0,25°C. Le fonctionnement dans une température ambiante de −40°C devrait être possible à condition qu'une longue période de chauffage soit tolérable.

Ausstellung für ELEKTRONISCHE BAUELEMENTE

Beschreibung einer Auswahl der auf der Ausstellung des Verbandes der Hersteller von Radio- und elektronischen Bauelementen in den Olympia-Hallen, London, vom 30. Mai bis 2. Juni gezeigten Bauelemente nach Angaben der Hersteller. *Übersetzung der Seiten 460 bis 466*

ANCILLARY DEVELOPMENTS LTD

Ancilo Works, Surrey Avenue, Camberley, Surrey

GERADE POTENTIOMETER

(Abbildung Seite 460)

Die geraden Potentiometer Baumuster ADR wurden entwickelt, um lineare Wegmessungen ohne Verstärker, Demodulatoren usw. mit grösster Genauigkeit durchzuführen. Typische Verwendungszwecke sind Rückkopplungs-Potentiometer für Flugzeug- und Werkzeugmaschinensteuerung sowie Untersuchung von Fahrzeugfederungen.

Das Bauelement besteht aus einer Steuerspindel aus nichtrostendem Stahl, die sich frei um ihre eigene Achse dreht und ausserdem in reibungsarmen Gleitlagern verschoben werden kann. Diese Spindel ist mit dem Ganzmetallträger des Doppelkontakt-Schleifers zusammengebaut.

Die Edelmetallschleifer arbeiten auf beiden Seiten des präzisionsbewickelten Dornes und werden durch rhodiumplattierte Messing- oder Neusilberführungsstangen in ihrer richtigen Lage gehalten.

Das eloxierte Aluminiumgehäuse und Endplatten mit Schwenklagern an einem Ende vervollständigen den Zusammenbau. Die Ausrüstung mit Schwenklagern erlaubt Messen in mehr als einer Ebene, z.B. bei schwingender Bewegung.

Die Potentiometer sind mit 25 ... 279 mm Hub und Widerstand bis zu 1 MΩ lieferbar.

EE 35 751 *für weitere Einzelheiten*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

Crown House, Aldwych, London, W.C.2

RÖHREN UND ELEKTRONENSTRAHLRÖHREN

Unter den neuen Hochleistungsröhren für Fernseher ist die 30C17 zu erwähnen, eine Triode/Pentode hoher Verstärkung in Spanngittertechnik, die als eine der ersten Mischröhren für Betrieb in Tunern mit automatischer Verstärkungsregelung entwickelt wurde.

Die HF-Regeltetrode 30F27 ist eine weitere Hochleistungsröhre in Spanngittertechnik für Fernsehtuner. Die Vorteile gegenüber der üblicheren Doppeltriode in Kaskodenschaltung liegen in der geringeren Anzahl erforderlicher Schaltungselemente und der einfacheren und oft kompakteren Auslegung.

Zwei KW-Spanngitter-Pentoden stehen für die ZF-Stufen eines Fernsehers zur Verfügung: die 6F24 hat seine Steilheit von 15 mA/V bei 10 mA Anodenstrom, die in Wechsel- und Allstromempfängern überlegene Leistung gibt; die 6F25 kann ohne Kreuzmodulation grosse Eingangssignale aufnehmen und ist daher für gemeinsame ZF-Verstärker geeignet.

Die Leistungstriode/Beam-Tetrode kann einen höheren Spitzenstrom abgeben und in vielen Fällen in Vertikalablenkungsschaltungen von Fernsehern mit 110° und 114° Bildröhren Ersparnisse in der Konstruktion der Ausgangstransformatoren ermöglichen. Die 30P19 ist eine Beam-power-Röhre für Horizontalablenkungs-Ausgangsschaltungen; ihre Konstruktion verringert Störmuster, die im Bild auftreten könnten.

Die U193 ist eine Diode für Energierückgewinnung in Ausgangsstufen der Horizontalablenkung für 110° und 114° Bildröhren, die eine maximale Spitzennennspannung von 5,5 kV zwischen Heizfaden und Kathode hat.

Die in verschiedenen Fernsehern vorgesehenen neuen Ediswan Mazda 48 und 58 cm—Bildröhren Type CME1901 bzw. CME2301 werden ausgestellt. Sie wurden für verbesserte Bilddarstellung entwickelt, die 95% eines echten Rechtecks bildet. Dieses Resultat wurde durch einen Schirm erzielt, der mehr einem Rechteck entspricht und einen grösseren Krümmungshalbmesser hat. Die neuen Röhren sind mit den älteren 43- und 53 cm—Typen CME1705 vergleichbar.

Als Beispiele der Neuentwicklungen von Ediswan-Leistungsröhren werden ausgestellt: der Prototyp einer siedegekühlten Leistungstriode Vapotron V1503, die besonders für Schwingungstreiberverstärker entwickelt wurde, aber auch für HF-Leistung Verwendung findet; eine luftgekühlte Leistungstriode 16J12 für Sendereinsatz, an die die volle Heizfadenspannung sofort angelegt werden kann; und eine strahlungsgekühlte Triode 14D13 mit robuster gesinterter Glasbasis für Ball- und Schwingungsverstärker sowie andere NF- und niedrige HF-Verwendung.

EE 35 752 *für weitere Einzelheiten*

SYDNEY S. BIRD & SONS LTD

3 Palace Mansions, Palace Gardens, Enfield, Middlesex

UHF-TUNER

(Abbildung Seite 460)

Dieser Tuner besteht aus einem HF-Verstärker in Gitterbasisschaltung und einer selbstschwingenden Mischstufe; er ist für Durchstimmen über den Frequenzbereich 470 ... 790 MHz ausgelegt, wobei Lecher-Leitungen mittels eines Dreifachdrehkondensators abgestimmt werden.

Die Abstimmspindel treibt den Abstimmkondensator über eine im Tuner eingebaute Untersetzung von 5:1.

Bei UHF ist die mechanische Stabilität des Bausteins von grösster Bedeutung; sie wird in diesem Falle durch ein tiefgezogenes Stahlgehäuse mit 1,63 mm Wandstärke erzielt. Das Gehäuse ist durch Stahlplatten unterteilt, um die für Eingang, Abstimmung und Ausgang erforderlichen Fächer zu schaffen. Zur Verminderung der Oszillatorstörstrahlung dient eine Kupferfoliendichtung, die durch ein Gummikissen und den Stahldeckel unter Druck gehalten wird.

Die breitbandige Eingangsschaltung besteht aus einem π-Filter, das für genaue Anpassung der Gitterbasis-Eingangsstufe an die Antenne ausgelegt ist. Eingangsverbindungen sind sowohl für symmetrische als auch unsymmetrische Systeme vorgesehen.

Das durchstimmbare Bandfilter hat über den gesamten Abstimmbereich eine Bandbreite von 5 ... 7 MHz. Die Bandfilterkreise werden durch Schlitze in der Trennwand gekoppelt. Die Kopplung des Bandfilters zur Mischstufe erfolgt durch eine Induktionsschleife.

Die verwendete selbstschwingende Mischstufe in Gitterbasisschaltung wurde

so ausgelegt, dass die zusätzliche Frequenzdrift auf ein Minimum reduziert ist.

Der ZF-Übertrager ist mit der Mischstufe über ein Filter verbunden, um die Energiestrahlung vom Oszillator durch den ZF-Teil herabzusetzen. Ankopplungsverbindung für den ZF-Übertrager ist vorgesehen.

EE 35 753 *für weitere Einzelheiten*

PERMEABILITÄTSTUNER

(Abbildung Seite 461)

Diese kompakten Permeabilitätstuner wurden für Verwendung mit kapazitivem Eingang in Autoradios, Portables und anderen transistorisierten Empfängern entwickelt. Der Baustein besteht aus Spulen für die Signalfrequenz und Oszillatorkreise, deren Induktivität durch Veränderung der Eintauchposition von Mehrfachkernen durch Drehung einer eingebauten Abstimmspindel erfolgt.

Alle Cyldon-Tuner RT8 wurden für Betrieb in abgesprochenen Schaltungen genau abgeglichen geliefert, so dass die einzige erforderliche Abgleichung im Empfänger in der Einstellung von Trimmerkondensatoren bei bestimmten Abgleichfrequenzen besteht.

In allen Fällen werden die Tuner mit den veränderlichen Spulen der Grundschaltung für die MW- und/oder UKW/FM-Bänder geliefert.

Die Abbildung zeigt von links nach rechts einen zweispuligen AM- oder FM-Tuner, einen dreispuligen AM-Tuner und einen kombinierten AM/FM-Tuner.

EE 35 754 *für weitere Einzelheiten*

G. & E. BRADLEY LTD

Electrical House, Neasden Lane, London, N.W.10

G. & E. Bradley Ltd. ist eine der Joseph Lucas (Electrical) Ltd. angegliederte Firma, die den Vertrieb und die Anwendung der von der letzteren Firma hergestellten Halbleiter-Geräte unternimmt.

DIODEN-SPERRKENNDATEN TESTER

(Abbildung Seite 461)

Der Bradley-Tester für Dioden-Sperrkenndaten gibt eine sichtbare Anzeige der Spitzendurchbruchsspannung und der Güte der Sperrschichten. Die tatsächliche Spitzensperrspannung und der Sperrstrom können mit Hilfe des eingebauten Instrumentes gemessen werden. Der Transistor-Kollektorreststrom kann auch bei den gewünschten Spannungen bestimmt werden, wenn man die Kollektor-Emitter-Strecke als Diode betrachtet, wobei Emitter und Basis kurzgeschlossen sind. Ein 4stufiger Schalter auf der Frontplatte erlaubt wahlweise Einstellung von Testspannung zwischen 250 V und 1500 V, und mit einem anderen Schalter können fünf Bereiche für die Stromanzeige des Messgerätes eingestellt werden.

EE 35 755 *für weitere Einzelheiten*

DATENSPEICHERGERÄT

(Abbildung Seite 461)

G. & E. Bradley hat für die Elektronphysikalische Fakultät der Universität Birmingham einen Datenspeicher für den englisch-amerikanischen Satelliten Scout entwickelt und konstruiert. Die Falkultät will das Gerät für Versuche einsetzen, in denen die Elektronendichte entlang der Umlaufbahn des Satelliten gemessen werden soll.

Information über die in den ersten 10 Sekunden jeder 61-Sekunden-Periode auftretende höchste Elektronendichte wird in den Speicher durchgelassen. Gegen Ende der Periode wird die Information ausgelesen und entweder zur sofortigen Übertragung in das Fernmessystem gespeist oder für spätere Übertragung zur Erde auf Magnetband aufgezeichnet. Die Vorgangsfolge ist Löschen, Durchlassen, Einschreiben, Speichern und Auslesen. Diese Folge wird alle 61 Sekunden wiederholt, wobei die Steuerung jedes Vorganges von der Hauptuhr des Satelliten aus erfolgt.

Der Stromverbrauch ist gering und bei voller Ausgangsleistung nur annähernd 0,6 mW pro Speicher, wobei diese Energie dem Sonnenzellensystem des Satelliten entnommen wird.

Das Gerät ist in Form einer Standard-Einheit gebaut und enthält acht identische Speicher.

Es ist volltransistorisiert und äusserst kompakt mit 180 Bauelementen—hauptsächlich Silizium-Transistoren und -Dioden—in einem Raum von 133,5 mm Durchmesser und 31,75 mm Höhe und wiegt ohne Umhüllung ungefähr 227 g.

Das Gerät wurde für absolute Betriebssicherheit während der erwarteten Lebenszeit des Satelliten und auch für Widerstand gegen die periodischen Änderungen und ausserordentlichen Temperaturen im Weltraum konstruiert.

EE 35 756 *für weitere Einzelheiten*

BRAYHEAD LTD

Kennel Ride, Ascot, Berkshire

MINIATUR-ZWISCHENÜBERTRAGER

(Abbildung Seite 461)

Brayhead Ltd. zeigt verschiedene neue Ausführungen von Zwischenübertragern und Oszillatorspulen für Transistor-Rundfunkgeräte. Die Firma hat ein Subminiatur-Fertigungsprogramm für Bauelemente aufgenommen, die in Abschirmhauben von 7 × 7 mm Grundfläche und 11 mm Höhe untergebracht sind, um den Forderungen der Konstrukteure von Kleinstempfängern zu entsprechen. Diese Übertrager haben einseitige Abstimmung, ein Q von 110 und werden mit Wicklungen geliefert, die für Anpassung an alle z.Z. in Heimempfängern benutzten Transistoren geeignet sind.

ZF-Bandfilter sind jetzt lieferbar, die den zusätzlichen Vorteil haben, dass die Abstimmkerne vom oberen Ende der Haube, deren Grundfläche 24 × 12,5 mm und Höhe 19 mm ist, aus verstellt werden können. In dieser Haubengrösse können für den letzten Zwischenübertrager auch die Diode und der Filterkondensator untergebracht werden; sie stellen eine für tragbare Hochleistungsempfänger herkömmlicher Grösse besonders geeignete Bausteinserie dar.

EE 35 757 *für weitere Einzelheiten*

BRUSH CRYSTAL CO. LTD

Hythe, Southampton, Hampshire

KERAMIKFILTER

Diese aus piezoelektrischem Keramikwerkstoff hergestellten Bauelemente werden als Oberschwingungs-Transfilter (T.O.-Reihe) und Grundschwingungs-Transfilter (T.F.-Reihe) bezeichnet und erübrigen anfängliche und nachfolgende Nachstimmungen. T.O.-Transfilter sind Keramikfilter mit Anpassungseigenschaften. Die piezoelektrische Scheibe schwingt mit der ersten Harmonischen ihrer radialen Grundschwingung. Das Filter bildet einen Vierpol mit hoher Eingangs- und niedriger Ausgangsimpedanz. Bei geeigneter Schaltungstechnik kann das Oberschwingungs-Transfilter den Übertrager oder induktive und kapazitive Bauelemente in herkömmlichen frequenzabhängigen Schaltungen ersetzen.

Das T.F.-Transfilter kann einen Emitter-Ableitkondensator ersetzen. Diese Bauelemente verbessern die Selektivität und langfristige Zuverlässigkeit; ausserdem vereinfachen sie die Arbeitsweise der Schaltung. Sie sind für gedruckte Schaltungen besonders geeignet und können mit automatischen Zusammenbaumethoden montiert werden.

Die Bauelemente werden durch Feuchtigkeit nicht beeinflusst und arbeiten gut in hohen Temperaturen.

EE 35 758 *für weitere Einzelheiten*

BEZUGSSPANNUNGS-BAUSTEINE

Wiederholter Bedarf für ein Bezugsspannungsgerät für wechselnde Stromstärke, Steilheit und Temperatur führte zur Entwicklung des Brush Statavolt.

Dieses patentierte Gerät besteht hauptsächlich aus einer Anzahl von Dioden in Serien- und/oder Parallelverknüpfung mit Eingangs- und Ausgangskenndaten, die den Wünschen der einzelnen Konstrukteure entsprechen.

Der stabile Aufbau macht das System für die meisten Verwendungszwecke geeignet. Es kann entweder in Aluminiumlegierung oder in Kunststoff (Polyamid, Melamin oder PVC) geliefert werden. Das Aluminiumlegierungsgehäuse ergibt eine wirksame Wärmeableitung, die höhere Verlustleistungen zulässt, während das Kunststoffgehäuse Verwendung von Hochspannungsdioden in Serienschaltung und Isolation des

Gerätes von anderen Bauelementen erlaubt.

Typische Verwendungszwecke sind so verschieden wie Benutzung als elektronische Normalzelle mit einem Bezugspegel von 1,1 V und einem Nenntemperaturbeiwert von Null, und als stabilisiertes Netzgerät für 3000 V mit 5 V—Abgriffen bei vorgeschriebenem Temperaturbeiwert.

EE 35 759 *für weitere Einzelheiten*

BURNDEPT LTD
Erith, Kent

NAHWIRKUNGSSCHALTER

(Abbildung Seite 462)

Type BE.238 ist ein preiswertes, stabiles und empfindliches Nahwirkungs-Bauelement für Füllstandregelung, Zählung, Einleitung von Arbeitsvorgängen usw.

Zur Füllstandregelung stehen zwei Modelle zur Verfügung: BE.238 für den niedrigen Stand und BE.238/HL für den hohen Stand, die beide bei Ausfall betriebssicher abschalten. Sie ermöglichen eine zuverlässige Regelung für leitende oder nichtleitende Pulver, Flüssigkeiten oder körnige Materialien. Type BE.238 ist für Dauerbetrieb unter ungünstigen industriellen Bedingungen konstruiert und wird durch Staub, Feuchtigkeit oder Erschütterungen nicht beeinflusst. Feuer- und explosionssichere Ausführungen können geliefert werden.

Die Wirkung des BE.238 beruht auf dem kritischen Wert der Abstimmkapazität eines quarzgesteuerten Oszillators, bei dessen Überschreitung die Schwingungen sehr plötzlich aussetzen. Der Messkopf bildet einen Teil dieser Kapazität, und jede durch den Messkopf wahrgenommene zusätzliche Kapazität verursacht Aussetzen der Schwingungen und Betätigung der Umschaltkontakte eines Relais. Diese Kontakte werden zur Ausführung der gewünschten Regelung benutzt.

Eine Kapazitätsänderung von 0,05 pF kann wahrgenommen werden. Grob- und Feineinstellung, durch die die Empfindlichkeit dem Verwendungszweck entsprechend eingestellt werden kann, ist vorgesehen.

Der BE.238 kann zuverlässig 1000 Gegenstände pro Minute wahrnehmen, wobei die Relaiskontakte zum Schalten des Steuerkreises benutzt werden. Für höhere Zählgeschwindigkeiten kann ein Impuls entnommen werden, der ein beliebiges zugeordnetes elektronisches Gerät speist.

Standard-Messköpfe sind in grosser Auswahl lieferbar und können auch für Sonderzwecke entwickelt werden.

EE 35 760 *für weitere Einzelheiten*

FÜLLSTAND-MONITOR

(Abbildung Seite 462)

Der Füllstand-Monitor BE.291 gibt automatisch eine kontinuierliche Standanzeige des Inhalts jedes beliebigen Materials in pulvriger, flüssiger oder körniger Form, vorausgesetzt, dass dieser Stand in eine entsprechende elektrische Kapazitätsänderung umgewandelt werden kann.

In einer typischen Anlage ist ein Messkopf im oberen Ende eines Tanks oder Kastenspeichers aufgehängt. Der Inhalt kommt mit dem Messkopf in Berührung und ruft eine elektrische Kapazitätsänderung hervor, die der vom Inhalt überdeckten Länge des Messkopfes proportional ist. Durch den Nahwirkungsschalter wird die Kapazitätsänderung in eine entsprechende Stromänderung umgewandelt, die auf einem Drehspulinstrument angezeigt wird.

Die Inhaltsanzeige kann mittels eines externen Instrumentes innerhalb jeder angemessenen Entfernung wiederholt werden.

Die Entfernung zwischen dem Messkopf und dem BE.291 ist normalerweise auf 2,13 m beschränkt; für längere Kabel kann jedoch ein Anpassungsgerät BE.271 eingesetzt werden.

Der BE.291 benutzt ein patentiertes kontinuierliches Abtastsystem, das ohne mechanisch bewegliche Teile über einen kapazitätsbetätigten Nahwirkungsschalter arbeitet. Das in Nahwirkungsschaltern übliche Relais mit beweglichem Anker ist durch einen Transistor ersetzt. Die Abtastung des Tankinhaltes erfolgt mit einer Frequenz von 50 Hz, und daher kann der BE.291 auf schnelle Standänderungen ansprechen. Das System ist betriebssicher ausgelegt, da beim Ausfallen einer elektronischen Röhre oder eines Transistors die Abtastung aufhört und das Instrument unabhängig vom Stand im Tank "Tank voll" anzeigt.

EE 35 761 *für weitere Einzelheiten*

GROSSBEREICH-LEISTUNGSMESSER

(Abbildung Seite 462)

Der BE.281 ist ein kompaktes, tragbares Gerät für Leistungsmessungen bis zu 1,5 W im Frequenzbereich von 1 kHz ... 1 GHz. Das Gerät ist in ein Gehäuse nach R.A.E.-Normen eingebaut.

Der Leistungsmesser ist durch einen koaxialen, in einen Exponentialhohlraum eingebauten Abschlusswiderstand genau auf 50Ω angepasst. Benutzt wird ein Schichtwiderstand auf keramischem Träger mit einem Abgriff 5Ω von der Erdseite. Das an diesem Punkt abgegriffene Signal wird durch eine Silizium-Diode gleichgerichtet.

Die Anzeige erfolgt auf einem hermetisch abgeschlossenen 102 mm-Instrument mit einer Empfindlichkeit von 50 μA und drei Skalen: 0...1,5 W, 0...300 mW und 0 ... 100 mW Vollausschlag. Die niedrigsten geeichten Skalenpunkte sind 50, 10 bzw. 5 mW.

Ein federbelasteter Hebelschalter ist immer für die 1,5 W Stellung vorgespannt und schützt auf diese Weise die empfindlicheren Bereiche. Als Eingangsklemme ist eine 50Ω-B.N.C.-Buchse vorgesehen.

Schnelles Ansprechen ist ein besonderes Merkmal des BE.281 im Vergleich zu dem ziemlich langsamen Ansprechen der Bolometer-Leistungsmessertypen. Durch das schnelle Ansprechen ist der Leistungsmesser für Ausgangsmessungen von Radiosendern wie z.B. Luftfahrt- und See-Rettungsfunkfeuer mit Impulsbetrieb und für jeden niedrigen, modulierten Leistungspegel im UKW- und UHF-Band geeignet.

EE 35 762 *für weitere Einzelheiten*

ELECTRO ACOUSTIC INDUSTRIES LTD
Stamford Works, Broad Lane, Tottenham, London, N.15

MINIATUR-LAUTSPRECHER

(Abbildung Seite 462)

Die neu eingeführten "Compact"-Lautsprecher sind in erster Linie für tragbare Transistor-Empfänger gedacht. Vier Modelle mit 50,8 mm, 57,2 mm, 76,2 mm und 85,7 mm Durchmesser werden hergestellt. Alle Lautsprecher haben einen hohen akustischen Wirkungsgrad, und der Durchschnittsfrequenzgang der beiden grösseren Modelle ist 200 ... 5000 Hz bzw. 150 ... 7000 Hz.

EE 35 763 *für weitere Einzelheiten*

ELLIOTT-AUTOMATION LTD
34 Portland Place, London, W.1

VERÄNDERLICHER KOAXIALRICHTKOPPLER

(Abbildung Seite 463)

Dieser von der Radar Division der Elliott Bros. (London) Ltd. hergestellte Prototyp beruht auf dem "Rückkopplungs"-Effekt zwischen zwei benachbarten Koaxialleitungen mit einem Schlitz in der gemeinsamen Wand. Änderungen der relativen Lage der besonders geformten inneren Leiter regeln die von der Hauptleitung in die Nebenleitung übertragene Leistungsmenge. Die gekoppelte Leistung kann daher in der Hauptleitung gleichmässig von -6 dB...-40 dB geregelt werden. Die Kopplung wird auf einer Skala mit Digitaleinteilung angezeigt, die mit der Bedienungsspindel verbunden ist und eine Eichgenauigkeit von ±0,1 dB hat. Die höchste Kopplungsschwankung über einen Oktavenfrequenzbereich ist für jede beliebige Einstellung niedriger als 2 dB.

Wenn das unbenutzte Leitungsanschlusspaar durch richtig angepasste Widerstände (die auch in den Baustein eingebaut werden können) abgeschlossen ist, so ist das Eingangsstehwellenverhältnis bei maximaler Kopplung niedriger als 1,3 (0,77) und für alle anderen Einstellungen niedriger als 1,2 (0,83). Ein vorhandenes Modell überstreicht die Frequenzbereiche 600...1200 MHz und ist für eine Durchschnittsleistung von 10 W und Spitzenleistung von 10 kW bemessen.

EE 35 764 *für weitere Einzelheiten*

VERSTÄRKER FÜR STELLMOTORE UND IMPULSFORMUNG

(Abbildung Seite 463)

Elliott Transistor-Verstärker für Stellmotore und Impulsformung sind für Betrieb in Temperaturen bis zu 100°C ausgelegt. Sie sind besonders für Verwendung mit Elliott Stellmotoren geeignet, können aber auch mit anderen Fabrikaten benutzt werden, solange sie mit geeigneter Impedanz vorhanden sind.

Die Endstufe hat veränderliche Verstärkung und niedrige Drift. Der Frequenzgang des Verstärkers und Stellmotors hat eine Phasennacheilung von 90° über 200 Hz.

Der Verformungsverstärker ist ein vielseitiger Verstärker mit einer Leerlaufverstärkung von 16 V/μA und einer niedrigen Drift.

EE 35 765 *für weitere Einzelheiten*

MAGNETKÖPFE

(Abbildung Seite 463)

Die im Elliott-Magnetband-Datenerfassungssystem benutzten metallbelegten Ferritkernköpfe sind jetzt als einzelne Einsteckbausteine lieferbar.

Die Aufzeichnungsköpfe sind für Analog- oder Digitalaufzeichnungssysteme mit jeder üblichen Modulationsform geeignet. Die Kombination von Ferritkernen und weitgehend reduzierter Spaltbreite erlaubt Aufzeichnungs- und Wiedergabefrequenzen von 4 kHz/Zoll (1575 Hz/cm) Bandgeschwindigkeit.

Standardköpfe werden nach britischen (S.B.A.C.) oder amerikanischen (I.R.I.G.) Normen hergestellt. Verschiedene Spurenanordnungen sind für ¼" (6,35 mm), ½" (12,7 mm) und 1" (25,4 mm) Bandbreite lieferbar.

Die durch Patente geschützte Konstruktion ergibt ausgezeichnete Azimusausrichtung zwischen Spuren und macht teuren Kopfersatz unnötig. Wenn Kopfabnutzung auftritt, brauchen lediglich die Polschuhe ersetzt zu werden, um eine Leistung "wie neu" zu erzielen.

Der Spurenabstand für untereinanderliegende Spalte ist 1,5 oder 3 mm und für die Spaltensprunganordnung 1,8 mm. Die Spurbreite für die erste Spaltanordnung ist 0.85 oder 1,9 mm und für die letztere 1.3 mm. Die Spaltbreite liegt zwischen 3 und 5μ. Die Induktivität des Aufzeichnungskopfes ist 0,5 mH und die des Wiedergabekopfes 10...15 mH.

EE 35 766 *für weitere Einzelheiten*

TRANSISTORISIERTES LOGIK-SYSTEM

(Abbildung Seite 463)

Panellit Limited, eine Firma der Elliott-Automation Gruppe, stellte eine neue, völlig umhüllte Ausführung des kontaktlosen, transistorisierten logischen Systems "Minilog" für industrielle Folgeschaltung und Steuerung aus.

"Minilog" kann sowohl für einfache als auch komplexe logische Systeme Verwendung finden. Es ersetzt Relais, Schrittschalter und ähnliche Bauelemente und erhöht sowohl Geschwindigkeit als auch Betriebssicherheit. Es besteht durchweg aus Festkörpern, braucht keine Wartung und gewährleistet störungsfreien Betrieb unter den schwierigsten Umgebungseinflüssen.

Zwei "Minilog"-Bausteintypen sind lieferbar. Eine hat sechs Eingänge, die eine "umgekehrte und"-Funktion geben, und einen Ausgang, der bis zu fünf Eingänge treiben kann; die andere enthält einen Emitter-Verstärker und kann mit ihrem Ausgang bis zu 25 Eingänge treiben. Beide haben genau dieselben Abmessungen (50,8 × 21,6 × 16 mm) und einen Raumbedarf von etwas über 16 cm³. Sie sind mit elf verzinnten 0.8 mm starken Kupferanschlussdrähten ausgerüstet. Transistor-Leistungsbausteine können als Kopf- oder Fusspunkt-Treiber zur Betätigung von Magnetspulen und ähnlichen Vorrichtungen bis zu max. 50 V 1 A geliefert werden.

48 "Minilog"-Bausteine können auf eine 254 × 432 mm grosse Schichtplatte montiert werden. Ein besonderes "Minilog"-Chassis mit vergoldeten Steckern und Buchsen kann die erforderlichen Verbindungen zwischen bis zu 12 dieser Platten sowie für Signale und Stromversorgung aufnehmen.

EE 35 767 *für weitere Einzelheiten*

ENTHOVEN SOLDERS LTD

Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16

VORFORMLINGE FÜR LEISTUNGSTRANSISTOREN

Diese Vorformlinge wurden entwickelt, um zwischen einem Leistungstransistor und seiner Wärmeableitung zur Erzielung höchster Wärmeübertragung einen innigen Kontakt herzustellen.

In Fällen, in denen der Transistorsockel aus einem gegossenen Werkstoff hergestellt wird, entstehen durch Unvollkommenheiten der Oberfläche Luftspalten zwischen dem Transistorsockel und dem Bausteir, auf den der Transistor montiert wird. Dasselbe trifft in einem geringeren Masse auch für bearbeitete Sockel zu. In beiden Fällen ist die Wärmeübertragung keineswegs ideal.

Die Verwendung von Leistungstransistor-Vorformlingen zwischen den beiden Metallflächen beseitigt das durch die unvollkommenen Oberflächen entstandene Spiel und gewährleistet somit wirksame Wärmeübertragung vom Transistorsockel. Die verschiedensten Werkstoffe, aus denen Vorformlinge hergestellt werden können, geben günstige Resultate, können aber auf Grund ihrer unter gewissen Bedingungen korrodierenden Natur bei Berücksichtigung der Militärforderungen nicht benutzt werden. Leistungstransistoren mit länglichrundem Sockel (der in Betracht gezogenen Type) werden in verschiedenen Ländern und entsprechend einem gemeinsamen Pflichtenblatt hergestellt, so dass die interstaatlichen Forderungen der Militärbehörden ohne Schwierigkeiten erfüllt werden können. Daher sollten die Enthoven-Vorformlinge bei Betriebstemperaturen bis zu 50°C überall gleichförmige Resultate ergeben.

EE 35 768 *für weitere Einzelheiten*

ERIE RESISTOR LTD

1 Heddon Street, London, W.1

KERAMISCHE KLEINKONDENSATOREN

Der Transcap Typ T ist eine Miniatur-Scheibenform eines Keramikkondensators hoher Kapazität für Ankopplung oder Entkopplung bei niedriger Spannung. Er hat einen Durchmesser von 15,1 mm und ist 4 mm dick. Die Kapazität ist 0,5 μF bei einer Betriebsgleichspannung von 3 V. Der bei 1 kHz gemessene Verlustfaktor ist 5%. Andere Kapazitätswerte und Betriebsspannungen werden später eingeführt.

Typen Y und Z sind keramische Kleinst-Rohrkondensatoren, die hauptsächlich für Einbau in ZF-Übertrager gedacht sind. Beide haben einen Durchmesser von 2,5 mm; Typ Y ist 5,6 mm und Typ Z 7,6 mm lang. Der Kapazitätsbereich für den ersteren Typ ist von 150 bis 200 pF und für den letzteren 201 bis 300 pF. Die Betriebsspannung für beide Typen ist 150 V und der Verlustfaktor 0,2%.

Der "Discoidal" ist ein keramischer Miniatur-Durchführungskondensator mit einer Kapazität von 1000 pF und einer Betriebsgleichspannung von 350 V.

Die kompakte Bauart der Discoidal-Durchführung ermöglicht die Ausbreitung des Stroms von der Mittelelektrode in einem 360°-Muster, wodurch der kürzeste elektrische Weg zwischen dem Mittelanschluss und dem Chassis vorgesehen wird. Die interne Serieninduktivität wird dadurch auf dem kleinstmöglichen Wert gehalten; verhältnismässig starke und kurze Anschlüsse gewähren externe Minimuminduktivität, mit der Kondensatoren dauernd behaftet sind. Diese Eigenschaften geben Discoidal besondere Eignung für UKW- und UHF-Verwendung. Für mechanische Festigkeit und Tropenfestigkeit ist das Bauelement hermetisch abgedichtet.

EE 35 769 *für weitere Einzelheiten*

FORTIPHONE LTD

92 Middlesex Street, London, E.1

MINIATURRELAIS

(Abbildung Seite 464)

Dieses als Type G.100 bezeichnete Relais wurde als hochwertiges Bauelement für Fernlenkwaffen für das britische Luftfahrtministerium entwickelt.

Eine symmetrische Ankerkonstruktion wird benutzt. Goldlegierte Kontakte finden Verwendung, um Kontaktverunreinigung zu verringern, und die Kontakte und Spulen sind in getrennten, hermetisch abgedichteten Abteilen untergebracht.

Der Betriebstemperaturbereich ist −55°C ... 125°C, und das Relais kann Beschleunigungen bis zu 100 g widerstehen. Die Kontakte sind für 0,3 A bei 50 V Gleichspannung bemessen, und Spulen sind für Spannungen zwischen 1,5 und 48 V lieferbar. Die Ansprech-/Abfallzeit ist unter 15 ms und der Kontaktwiderstand bei 10 mV geringer als 40 mΩ.

Sowohl zwei- als auch vierpolige Umschaltausführungen sind lieferbar. Die Abmessungen der ersteren sind 20,3 × 22,9 × 9,4 mm, die der letzteren 20,3 × 22,9 × 17,8 mm.

EE 35 770 *für weitere Einzelheiten*

GOODMANS INDUSTRIES LTD

Axiom Works, Wembley, Middlesex

KLEINSTLAUTSPRECHER

(Abbildung Seite 464)

Ein neues Fertigungsprogramm von Kleinstlautsprechern ist jetzt lieferbar. Die Chassiskonstruktion ist flach und der Magnetzusammenbau klein, um die Anordnung anderer Bauelemente so wenig wie möglich zu beeinflussen.

In dieser Serie sind fünf Grössen lieferbar (50,8 mm; 57,2 mm; 63,5 mm; 70 mm; 76,2 mm), und für jede Grösse stehen drei Magnete zur Verfügung. Zusätzlich ist die Typenzahl dadurch verdoppelt, dass jedes der Modelle mit umgekehrtem Magnetsystem lieferbar ist. Alle Modelle sind mit ultraleistungsfähigen Magneten ausgerüstet und Impedanzen von 3...80Ω sind vorgesehen.

EE 35 771 *für weitere Einzelheiten*

HUGHES INTERNATIONAL (U.K.) LTD

Glenrothes, Fife, Scotland

SCHALTDIODEN

Unter den in der neuen schottischen Fabrik hergestellten Schaltdioden befindet sich eine Reihe von Germanium-Spitzendioden, die besonders für industrielle Verwendungszwecke entwickelt wurden und in denen die besonderen Eigenschaften der Spitzendioden wie z.B. sehr gute Schaltzeit und geringe Kapazität wertvoll sind. Das Germanium-Programm wird durch Golddrahtdioden vervollständigt, deren Durchlassstrom und Schaltzeit sehr gut sind.

Zu den Silizium-Dioden gehören die Universaldioden der Bauform HS10, die als kleine Gleichrichter oder zum Schalten mit Frequenzen bis zu 100 kHz Verwendung finden. Die neu eingeführte Type HS1020 ist eine 200 V- Diode, die besonders dadurch interessant ist, dass sie bei Betrieb innerhalb der Grenzwerte ein Rück- zu Vorwiderstandsverhältnis von 5×10^8 hat. Das Programm wird durch die Rechner-Dioden Bauform HS11 vervollkommnet, die eine sehr gute Schaltzeit (typische gespeicherte Ladung 700 Picocoulombs) mit hoher Sperrspannung und niedrigem Sperrstrom verbinden.

EE 35 772 *für weitere Einzelheiten*

JAMES A. JOBLING & CO. LTD

Wear Glass Works, Sunderland

METALLSCHICHT-WIDERSTÄNDE

Neue als 'CJ' bezeichnete Metallschicht-Widerstände sind jetzt eingeführt worden. Das Fertigungsprogramm umfasst den CJ20, einen völlig isolierten ½ W—Widerstand, der 9,5 mm lang ist und einen Durchmesser von 3,8 mm hat, und den CJ32, einen völlig isolierten 10 W—Widerstand, der 12,7 mm lang ist und einen Durchmesser von 5,1 mm hat. Zu diesem Baumuster gehört auch der schon seit einiger Zeit hergestellte 2 W—Widerstand, der nunmehr die Typenbezeichnung CJ42 erhält.

Diese Widerstände sind hauptsächlich für Verwendung in Rechnern und ähnlichen Geräten gedacht.

EE 35 773 *für weitere Einzelheiten*

THE M.O. VALVE CO. LTD

Brook Green, Hammersmith, London, W.6

RÖHREN UND ELEKTRONENSTRAHLRÖHREN

Als neuste der periodisch fokussierten Wanderfeldröhren ist nunmehr die TWC5 in Hammersmith in Produktion. Sie ist ein Wanderfeldröhren-Leistungsverstärker, der im 5,8 ... 8,2 GHz-Band 11 W abgeben kann und dessen kaltes Eingangs- und Ausgangs-Stehwellenverhältnis niedriger als 2 : 1 ist. Sie wurde besonders für Mehrkanal-Fernmeldesysteme entwickelt und hat zwischen 5 925 und 6 425 MHz eine Spitzenausgangsleistung von 15 W. Die Anpassung im engeren Band ist besser als 1,4. Ähnliche Leistungen können in anderen engen Bändern erzielt werden.

Die LD603 ist eine neue 127 mm Oszillographen-Röhre mit äusserst wirksamer Nachbeschleunigung und damit hoher Ablenkempfindlichkeit. Die Ablenkempfindlichkeit der in Hammersmith hergestellten Röhre ist 9,5V/cm in X-Richtung und 3,7/Vcm in Y-Richtung. Die in dieser Röhre benutzte neue Nachbeschleunigungsform gibt gegenüber der spiralenförmigen Nachbeschleunigung eine dreifache Ablenkempfindlichkeit bei Beibehaltung einer Auslenkfläche von 10 cm × 6 cm.

EE 35 774 *für weitere Einzelheiten*

MINIATURE ELECTRONIC COMPONENTS LTD

The Lye, St. John's, Woking, Surrey

MINIATUR-POTENTIOMETER UND -WIDERSTÄNDE

(Abbildung Seite 464)

Das M.E.C.-Fertigungsprogramm für mehrgängige Trimmer-Potentiometer ist erweitert worden und umfasst jetzt ein Modell für gedruckte Schaltungen. Zwei- und Dreifachausführungen werden für Verwendungszwecke angeboten, in denen dieser Zusammenbau zu grösserer Raumersparnis führt. Als Alternative zu festen Endanschlägen können alle Typen jetzt mit Rutschkupplung geliefert werden. Diese Miniatur-Potentiometer werden in ein aus einem Stück bestehendes Gehäuse aus eloxiertem Aluminium eingebaut und mit Lötfahnen oder freien Enden geliefert. Im Bereich von 10Ω bis 125 kΩ werden 17 Standardwerte hergestellt, die über einen Temperaturbereich von −55° ... +150°C betrieben werden können und bei 50°C eine Verlustleistung von 2¼ W haben.

Ein neues Fertigungsprogramm von 15 Präzisions-Drahtwiderständen enthält fünf Miniaturausführungen, von denen drei besonders für gedruckte Schaltungen entwickelt wurden.

Die neuste M.E.C.-Entwicklung ist besonders interessant: ein Miniatur-Kippschalter mit nur 6,35 mm Durchmesser und 12,7 mm Tiefe. Trotz dieser kleinen Abmessungen ist der Schalter für 1 A bei 50 V Gleichspannung bemessen.

EE 35 775 *für weitere Einzelheiten*

MORGANITE RESISTORS LTD

Bede Trading Estate, Jarrow, Co. Durham

MINIATURPOTENTIOMETER

(Abbildung Seite 465)

Morganite Resistors Ltd haben einen neuen hochkantigen Miniaturregler Type 56 eingeführt, der besonders Konstrukteure kleiner transistorisierter Empfänger interessieren wird. Der Gesamtdurchmesser des Reglers ist nur 20,3mm, und Anschlüsse für gedruckte Schaltungen ermöglichen bequeme Montage des Bauelementes.

Trotz der geringen Abmessungen ist das durch Betätigung hervorgerufene Rauschen infolge der Verwendung eines langerprobten Widerstandselementes und einer neuen Kontaktkonstruktion sehr gering. Ein zuverlässiger, robuster einpoliger Schalter ist angebaut.

Das Potentiometer ist für 0,25 W bei 20°C bemessen und hat bei Linksdrehung einen Spitzenendwiderstand von 1Ω. Der Schalter ist für 50 V und max. 250 mA bemessen und hat einen Kontaktwiderstand von 0,02 (nach 10 000 Schaltvorgängen bei Vollast 0,05Ω).

EE 35 776 *für weitere Einzelheiten*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

SUBMINIATUR-TANTALKONDENSATOREN

Diese neuen Subminiatur-Tantal-Elektrolyt-Kondensatoren sind für Transistorgeräte geeignet.

Das innerhalb der Kondensatoren gebildete Tantalpentoxyd-Dielektrikum ist wesentlich dünner und kann höheren

Spannungen als das üblichere Aluminiumoxyd widerstehen. Dadurch ergeben sich ein grösseres Spannungs-Kapazitäts-Produkt und kleinere Abmessungen.

Das neue Fertigungsprogramm sieht 10 Typen vor, die entsprechend ihrer Nennkapazitäten und -spannungen in drei Gehäusegrössen hergestellt werden.

Die Abmessungen des kleinsten Gehäuses, das z.B. einen Kondensator von 0,64 µF bei 25 V Betriebsspannung oder einen von 1,6 µF bei 10 V Betriebsspannung aufnimmt, sind nur 2 mm × 5 mm; am anderen Ende der Skala stehen Kondensatoren bis zu 40 µF 2,5 V oder 16 µF 6,4 V Betriebsspannung, die in Gehäusen von 3 mm × 8,9 mm untergebracht sind.

Durch ihre winzigen Abmessungen sind diese neuen Kondensatoren besonders für Hörgeräte, Taschenempfänger usw. geeignet, in denen Raumersparnis von grosser Bedeutung ist. Da sie sehr stoss- und rüttelfest sind, auch bei niedrigem atmosphärischen Druck zufriedenstellend arbeiten, können sie erfolgreich in Flugzeug-Bordgeräten Verwendung finden.

Die übliche Höchsttemperatur ist 50°C, jedoch sind 60°C für 12 in jeweils 24 Betriebsstunden zulässig. Die Betriebsspannung kann um 10% erhöht werden, wenn die Temperatur 30°C nicht überschreitet.

Die neuen Kondensatoren werden hermetisch verschlossen in zylindrischen Silbergehäusen und durch Kunststoffüberzug extern isoliert geliefert.

EE 35 777 *für weitere Einzelheiten*

Drehkondensatoren Mit Festdielektrikum

Dies ist ein neuer Zweifach-Drehkondensator mit Festdielektrikum, der für die Abstimmung von Taschenempfängern entwickelt wurde.

Die beiden Pakete haben Kapazitäten von 0...180 pF (Antennenabstimmung) und 0...80 pF (Oszillatorabstimmung). Jedes Paket hat einen eingebauten Trimmer von 0...6 pF.

Die neuen Kondensatoren haben u.a. folgende Konstruktionsmerkmale: genau ausgerichtete Rotor- und Statorplatten aus Messing, verlustarmes Kunststoffdielektrikum, niedrigen Rauschpegel, keine Mikrophonie, grosse elektrische Stabilität und mechanische Festigkeit. Der Kondensator ist in einer Staubschutzabdeckung aus Kunststoff von 20 mm × 20 mm × 15 mm untergebracht. Montage erfolgt mittels zweier Gewindelöcher in derselben Oberfläche wie die Rotorspindel und so angeordnet, dass sie der 25 mm—Norm für Leiterplatten entsprechen. Die Anschlussstifte ragen nach unten heraus, so dass sie direkt in die gedruckte Schaltung gelötet werden können.

EE 35 778 *für weitere Einzelheiten*

Trimmer Mit Festdielektrikum

(Abbildung Seite 465)

Die neuen Trimmer mit Festdielektrikum geben eine zweckmässig grosse Kapazitätsänderung und stehen trotzdem sehr wenig über der Oberfläche der gedruckten Schaltung hervor.

Der Kapazitätsbereich ist 1,5...60 pF mit einer Einstellgenauigkeit, die besser als ±0,12 pF ist, und die Spitzenbetriebsgleichspannung 300 V. Die Höhe des Trimmers über der Leiterplatte ist 8 mm und die grösste Fläche 14 × 14 mm.

Der Trimmer ist in einem Staubschutzgehäuse aus klarem Kunststoff untergebracht, das so um das geschlitzte Ende des Rotors geformt ist, dass der Schraubenzieher während des Einstellens nicht abrutschen kann. Drei nach unten herausragende Anschlussstifte haben den dem 25 mm Raster für Leiterplatten entsprechenden Abstand und können direkt in die gedruckte Schaltung eingelötet werden.

Durch die kleinen Abmessungen ist der Trimmer für weitgehende Verwendung in Transistorgeräten geeignet.

EE 35 779 *für weitere Einzelheiten*

Verzweigungen und Symmetrische Mischstufen

Mullard Equipment Ltd. hat eine Reihe neuer symmetrischer Koaxialmischstufen und Koaxialverzweigungspunkte für Mikrowellenempfänger im Frequenzbereich 1 GHz...11,5 GHz entwickelt.

Die Hauptmerkmale dieser neuen Mikrowellen-Bauelemente sind der grosse, ohne Abstimmung überstrichene Frequenzbereich und die im Vergleich zu den äquivalenten Hohlleitern sehr kleinen Abmessungen. Sie sind besonders für nichtabgestimmte Empfängerschaltungen geeignet.

Sowohl die entkoppelten Verzweigungspunkte als auch die Mischstufe zeruhen auf Schaltungen mit neu entwickelter Phasenumkehr, die ohne Abstimmung über einen Frequenzbereich von 3:1 arbeiten können. Für die symmetrische Mischstufe werden geeignete Mischquarze und zugeordnete Anpassungsschaltungen in die entkoppelten Verzweigungspunkte eingebaut.

Die neue Verzweigungsschaltung ist eine Entwicklung der herkömmlichen Ringverzweigung, in der ein Leitungsstück durch eine Phasenumkehrschaltung ersetzt wird, deren Kennwerte im wesentlichen frequenzunabhängig sind. Abgesehen von der Entfernung eines frequenzabhängigen Leitungsstückes wird durch diese Anordnung die herkömmliche Schaltung in ein vierpoliges Netzwerk grosser Stabilität über einen grossen Frequenzbereich umgewandelt.

Das volle Programm umfasst fünf Mischstufen und fünf Verzweigungen, die zusammen die Bänder L1, L2, S, C und X überstreichen. Sie sind mit Standard-Koaxialverbindungen Typen C und N ausgerüstet, können aber auf Wunsch auch mit Hohlleiterflanschen geliefert werden.

EE 35 780 *für weitere Einzelheiten*

Elektrolyt-Kleinkondensatoren

(Abbildung Seite 465)

Das gegenwärtige Fertigungsprogramm für Mullard Elektrolyt-Kleinkondensatoren umfasst 22 Typen mit Kapazitätswerten zwischen 0,8 µF und 200 µF bei Betriebsspannungen zwischen 25 V und 4 V.

Durch Einführung von 18 weiteren Typen wurden die lieferbaren Kapazitätswerte bis auf 640 µF und die Betriebsgleichspannung auf max. 64 V erhöht.

Die Kondensatoren werden entsprechend ihrer Kapazität und Betriebsspannung in fünf verschiedene Gehäusegrössen engebaut. Im kleinsten Gehäuse (9,9 × 3 mm) sind z.B. Kondensatoren von 0,8 µF 25 V oder 4 µF 4 V Betriebsgleichspannung untergebracht; im grössten Gehäuse (8,9 × 30,5 mm) werden Kondensatoren bis zu 640 µF 2,5 V oder 32 µF 64 V Betriebsgleichspannung eingebaut.

Kondensatoren in den drei grössten Gehäusen können für Montage auf Leiterplatten mit gelber Kunststoffbasis geliefert werden, durch die zwei Anschlussdrähte zum direkten Einlöten in die gedruckte Schaltung ragen.

EE 35 781 *für weitere Einzelheiten*

Keramik-Trimmer

(Abbildung Seite 465)

Diese neuen Keramik-Trimmer hoher Qualität wurden für Geräte des Nachrichtenverkehrs entwickelt.

Drei Typen mit Kapazitäten von 0,7...3,7 pF, 0,8...6,8 pF bzw. 0,9...12 pF werden in dieser Ausführung hergestellt. Alle drei haben ein keramisches Dielektrikum und sind für 400 V Betriebsgleichspannung bemessen. Sie sind tropenfest und haben einen Betriebstemperaturbereich von −50°C...+100°C.

Die Trimmer sind röhrenförmig mit 5,84 mm Aussendurchmesser konstruiert und haben je nach Kapazität eine eingebaute Höhe von 9,9 mm, 13 mm oder 24 mm. Ein Gewindeansatz erlaubt Einlochmontage, und das spiralenförmige Abstimmelement ist an beiden Enden geschlitzt, so dass die Einstellung von der Unter- oder Oberseite des Chassis vorgenommen werden kann.

EE 35 782 *für weitere Einzelheiten*

R. B. PULLIN & CO. LTD

Phoenix Works, Gt. West Road, Brentford, Middlesex

Transistor-Verstärker

(Abbildung Seite 466)

Der Verstärker Type TA.16 ist mit den neusten Transistoren bestückt und für Betrieb von zehn Servomotoren oder Motorgeneratoren ausgelegt. In einer Umgebungstemperatur von +55°C gibt er eine Ausgangsleistung von 4 W und bei Temperaturen unter 50°C 6 W ab.

Der Verstärker ist in erster Linie für Betrieb mit 26 V, 400 Hz entwickelt,

kann aber auch alternativ von einer 18 V Gleichspannungsquelle gespeist werden.

Der abgebildete Verstärker Type TA.3 wurde für Abgabe der Steuerphasenleistung für Servomotoren bis und einschliesslich Grösse 15 entwickelt, kann jedoch bei Betrieb über einen Transformator mit Mittelanzapfung auch für andere Zwecke benutzt werden. Er gibt im Umgebungstemperaturbereich −40°C ... +70°C eine Ausgangsleistung von 7 W ab, wenn er von einer Stromquelle mit 13 V-0-13 V, 400 Hz gespeist wird. Mit den vorgegebenen Eingangskenndaten erzeugt ein Eingangssignal von 150 mV eine Leistung von 4 W.

EE 35 783 *für weitere Einzelheiten*

SEALECTRO CORPORATION

Hersham Factory Estate, Walton-on-Thames, Surrey

STEUERBRÜCKEN

(Abbildung Seite 466)

Das vielseitige "Sealectoboard"-Programmiersystem ist in verschiedenen Formen lieferbar. Grundsätzlich besteht das Sealectoboard aus Reihen von Beryllium-Kupfer-Kontaktstreifen, die in überlagerten Ebenen rechtwinklig zu einander montiert sind. Programmierung erfolgt durch Einführung von Kurzschlussstiften. Eine Anzahl von Buchsen kann in das Pflichtenblatt aufgenommen werden. Ein koaxialer Stecker, in den eine Diode oder ein anderes Bauelement eingebaut werden kann, ist ebenfalls lieferbar, so dass eine Digital- oder Substitutionsmöglichkeit besteht.

Neuerdings wurde eine Einzelbuchse eingeführt, die die Standardtype der Sammelbuchsen ergänzt und dem System noch grössere Anpassungsfähigkeit verleiht. Das System ist für schnurloses Programmieren ausgelegt, jedoch sind Stecker für Verbindungsschnüre lieferbar, die für Einzelbrücken Verwendung finden können.

EE 35 784 *für weitere Einzelheiten*

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313 Chase Road, Southgate, London, N.14

MESS-OSZILLOGRAF

(Abbildung Seite 466)

Modell S.42 wurde besonders für Verwendungszwecke entwickelt, für die grosse Schreibgeschwindigkeiten bei niedrigen Wiederholungsfrequenzen erforderlich sind. Die benutzte 10 cm—Oszillografenröhre mit Wendelnachbeschleunigung ermöglicht Beobachtung und Fotografieren eines einzelnen 1 μs—Impulses. Der Y-Verstärker hat bei hoher Verstärkung eine Bandbreite von 0...500 kHz und bei niedriger Verstärkung eine von 0...6 MHz. Im ersten Fall ist die Empfindlichkeit 10 mV/cm und im letzteren 100 mV/cm. Ein geeichter Eingangsabschwächer kann für Gleich- oder Wechseleingangsspannungen von 10 mV/cm bis zu 50 V/cm direkt abgelesen werden. Ein X-Dehnungsregler gibt stufenlose Dehnung bis zu 10 Bildschirmdurchmessern. Automatische oder wahlweise Triggerung ermöglicht Triggern des Kippgerätes von jedem vorgewählten Teil der Eingangswellenform.

EE 35 785 *für weitere Einzelheiten*

ZWEIKANAL-VORVERSTÄRKER

(Abbildung Seite 466)

Modell PA2 wurde für medizinische, biologische und elektromechanische Verwendungszwecke entwickelt, die hohe Empfindlichkeit erfordern. Das Gerät hat zwei unabhängige Kanäle mit hoher Trennung, die je zwei Pentoden in Kaskade mit einer Kathodenverstärkerendstufe haben. Die stabilisierte Anodenspannung des Netzanschlusses gewährleistet vollkommene Verstärkungskonstanz.

Der PA2 wurde in erster Linie für den Zweistrahl-Oszillograf "Serviscope" entwickelt, kann jedoch für jeden Telequipment-Oszillograf zur Erzielung einer geeichten Höchstempfindlichkeit von 1 mV/cm benutzt werden. Brumm- und Rauschpegel sind äusserst niedrig. Mit Typen S.42 und S.42A gibt der Vorverstärker eine Höchstempfindlichkeit von 100 μV/cm.

EE 35 786 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Sekundäres Rundsichtradargerät von D. H. R. Archer

Zusammenfassung des Beitrages auf Seite 414-420

In diesem Beitrag werden die Prinzipien und Grundeigenschaften sekundärer Radargeräte besprochen und einige der Konstruktionsprobleme aufgezeigt. Die verschiedenen Verfahren zur Dämpfung der Nebenzipfelabfrage werden ausführlich behandelt. Die Verwendung des Systems für Datenübertragungsverbindung wird zusammen mit seinen Erweiterungsmöglichkeiten und den Entwicklungstendenzen besprochen.

Eine einfache elektronische Akkordorgel von J. Venn

Ein Plan wird entwickelt, durch Konstruktion eines elektronischen Musikinstrumentes die Schwierigkeiten zu überkommen, auf die der Anfänger stösst, der ein Tastatur-Musikinstrument zu spielen lernt. In einem beschriebenen System wird durch Berührung eines einzigen Knopfes ein Vierklang in jeder gewählten Tonart erzeugt; der Ausbau dieses Systems zu einer melodischen Tastatur wird besprochen.

Zusammenfassung des Beitrages auf Seite 421-425

Allgemeine Angaben für eine Methode werden gemacht, nach der Vierklänge mit zusätzlichen "sechsten" und "siebenten" Tönen in jeder Dur- oder Molltonart durch Benutzung eines Systems "abgeglichener" Oszillatoren erzeugt werden. Ein nach dieser Methode ausgelegtes einfaches Instrument mit einstimmigem, tastaturbienten 3-Oktaven-Generator wird beschrieben. Einige Einzelheiten für die melodischen und Akkordoszillatoren, Oktaventeiler, Tonartstufen, Verstärker und Netzgeräte werden gegeben. Die Versuchsausführung eines solchen Instrumentes hat zufriedenstellend gearbeitet.

Silizium-Vierschichthalbleiter als Hochleistungs-Impulsgeneratoren von R. P. F. Lauder

Zusammenfassung des Beitrages auf Seite 426-431

Verschiedene angegebene Schaltungen zeigen, dass pnpn-Elemente in Zwei- oder Dreipolverknüpfung als Impulsgeneratoren benutzt werden können, die genaue rechteckige Leistungsimpulse für die verschiedensten Zwecke einschliesslich Sender mit Spitzeneingangsleistungsbereich von 20 kW abgeben.

Ein Wahrscheinlichkeitskurvenanalysator mit elektrostatischer Speicherung von I. K. Harvey

Zusammenfassung des Beitrages auf Seite 432-436

Ein Gerät wird beschrieben, das mit Hilfe elektronischer Technik die eindimensionale Wahrscheinlichkeitskurvenanalyse einer beliebigen elektrischen Variablen ermöglicht.

Binäre Digitalmethoden werden benutzt und die sich ergebenden Daten in einen elektrostatischen Speicher mit einer Kapazität von 960 Ziffern eingeschrieben.

Der zu untersuchende Amplitudenbereich wird in 64 Kanäle mit je 15 Ziffern Kapazität (32 767 Zählstösse pro Kanal) unterteilt.

Eine Linearität von $\pm$ 0,25% wird erreicht. Eingangswellenformen mit Frequenzen im Bereich von Null bis zur oberen Frequenzgrenze von 20 kHz können analysiert werden.

Ein Gleichspannungsverstärker mit niedriger Drift von D. J. Collins

Zusammenfassung des Beitrage sauf Seite 437-441

Es besteht eine natürliche Tendenz, erhöhte Genauigkeit für die Instrumentierung von Anlagen anzustreben. Einer der die Gesamtgenauigkeit eines mit niedrigen Gleichspannungen arbeitenden Systems beeinflussenden Faktoren sind die Betriebsdaten des Verstärkers. Der in diesem Beitrag beschriebene Verstärker wurde entwickelt, da ein Bedarf für Verstärker für eine Genauigkeit in der Grössenordnung von 0,1% des Vollausschlags bestand. Die Wahl der Verknüpfung, Anordnung der Schaltung und Betriebsparameter werden erwähnt. In diesem kommerziell lieferbaren Gerät wurde ein Eingangsdrift-Gegenwert unter 2 μV erreicht.

Die Theorie des gegengekoppelten Spannungsverstärkers von C. H. Vincent

Zusammenfassung des Beitrages auf Seite 442-443

Die Standardmethode für die Analyse gegengekoppelter Spannungsverstärker wird etwas abgewandelt. Die Abwandlung berücksichtigt die Tatsache, dass die abgeschwächte Gegenkopplungsspannung nicht immer direkt von der Eingangsklemmenspannung abgezogen werden kann, wie das üblicherweise in der Theorie angenommen wird. Der Grund dafür ist, dass normalerweise Mischschaltungen in irgendwelcher Form benutzt werden müssen. Sowie das erkannt ist, wird die Anwendung der allgemeinen Analyse ohne Sonderbehandlung für irgendeine besondere Schaltung einfach.

Ein Blutzellenzähler von G. P. Burn und P. J. Tosh

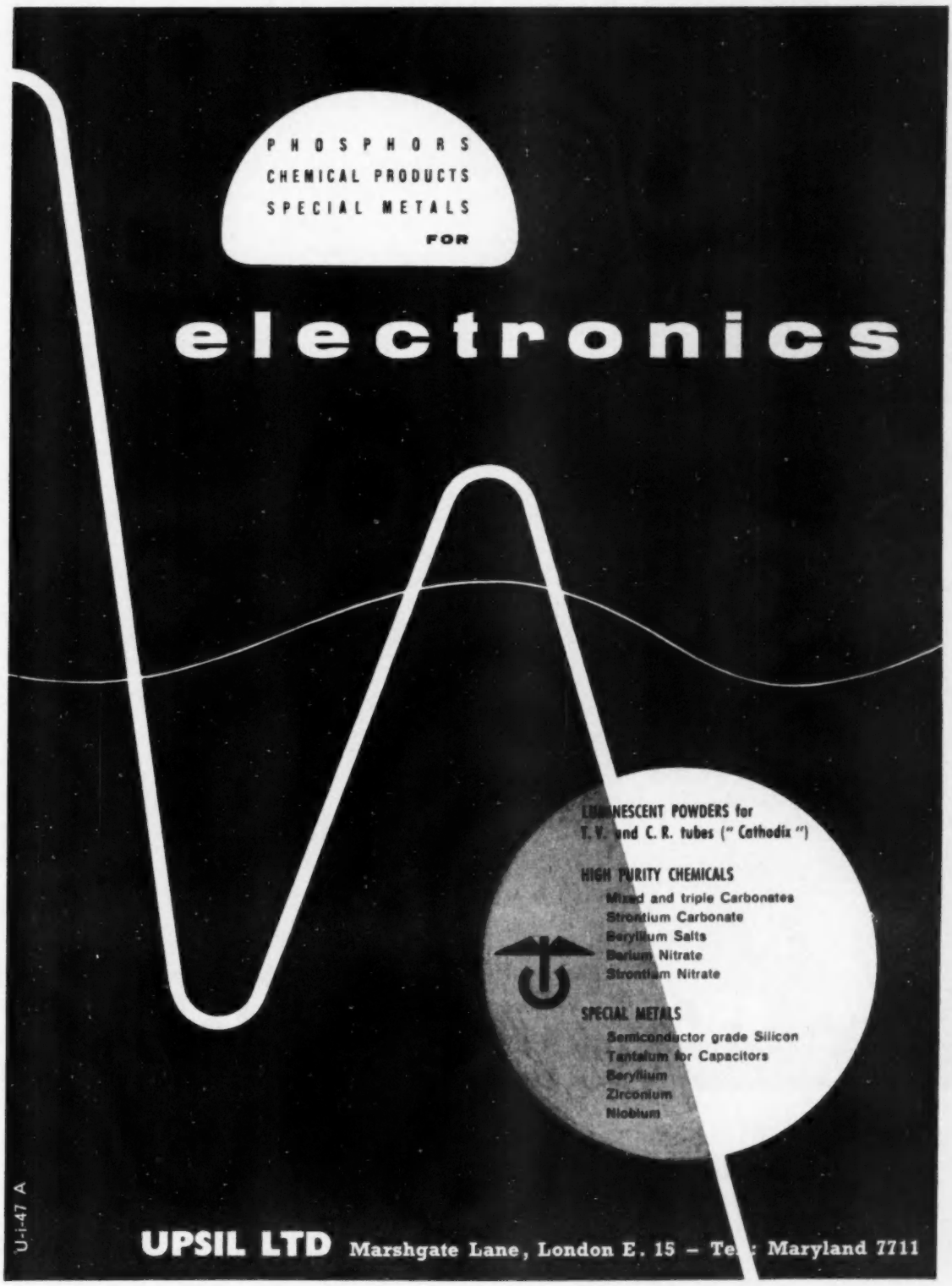
Zusammenfassung des Beitrages auf Seite 444-445

Der Beitrag beschreibt die Blutzellenzählmethode von Coulter. Das mit Dekatrons ausgerüstete Gerät kann 10 000 Zellen in ungefähr einer Minute zählen. Die Methode ist einfach und zuverlässig.

Eine Transistor-Umhüllung konstanter Temperatur von M. W. Rignall

Zusammenfassung des Beitrages auf Seite 452-453

Der Beitrag beschreibt eine Umhüllung, in der bei konstanter Temperatur zwölf Transistoren der OC201-Grösse untergebracht werden können. Sie besteht auseinem Aluminiumblock mit einem O29 als Heizelement und einem Thermistor als Temperaturfühler. Im Bereich von 35°C . . . 55°C ist die Inkonstanz für jeden gegebenen Wert geringer als 0,25°C. Betrieb in einer Umgebungstemperatur von $-$ 40°C sollte möglich sein, wenn eine lange Anwärmzeit in Kauf genommen werden kann.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TYPE	pF/ft	IMPED	O.D
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C11	6.3	173	.36
C2	6.3	171	.40
C22	5.5	184	.44
C3	5.4	197	.64
C33	4.8	220	.64
C4	4.6	229	1.03
C44	4.1	252	1.03

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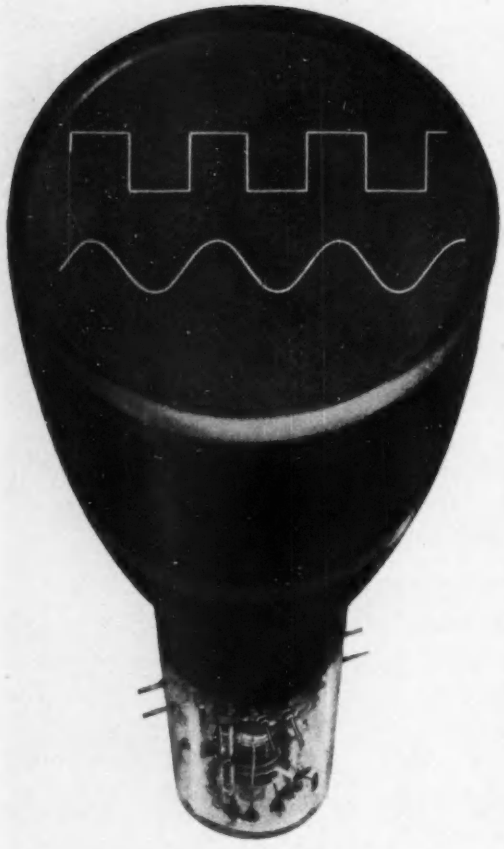
4LP31

P.D.A. tube with TWO traces from ONE gun



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4LP31 single gun dual trace tube.

SCREEN TYPE	*P31
DEFLECTION	electrostatic
POST-DEFLECTION ACCELERATOR ...	single stage
SCREEN DIAMETER	4 inches
MAXIMUM OVERALL LENGTH	15½ inches

*(*The green medium persistence phosphor used by E.T.L. has now been designated P31. It is exactly the same as the E.T.L. phosphor previously called P1.)*

Capacitances

$C_{x'-x''}$ ...	... 1.4 to 2.0 pF
$C_{x'-all}$ (x'' earthed)	... 2.7 to 3.8 pF
$C_{x''-all}$ (x' earthed)	... 2.7 to 3.8 pF
$C_{y'-all}$...	... 2.5 to 3.8 pF
$C_{y''-all}$	... 2.5 to 3.8 pF
$C_{y'-y''}$ ...	... <0.1 pF

Typical Operating Conditions

V_{a1}	... 1.5 kV
V_{a2}	320 to 420 V
V_{a3}	... 1.5 kV
V_{a4}	... 3.0 kV
V_g (for cut-off)	—40 to —95V
Sx	27 V/cm
Sy'	27 V/cm
Sy''	27 V/cm

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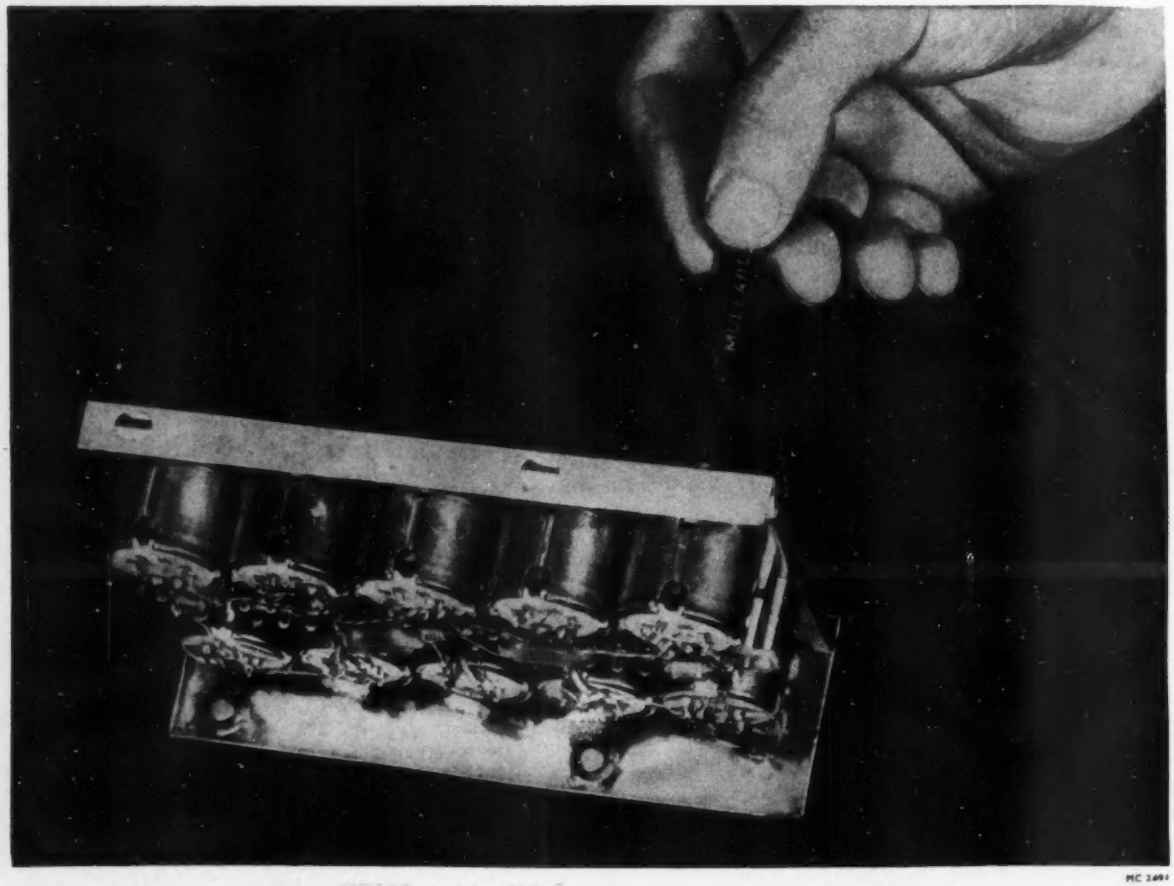

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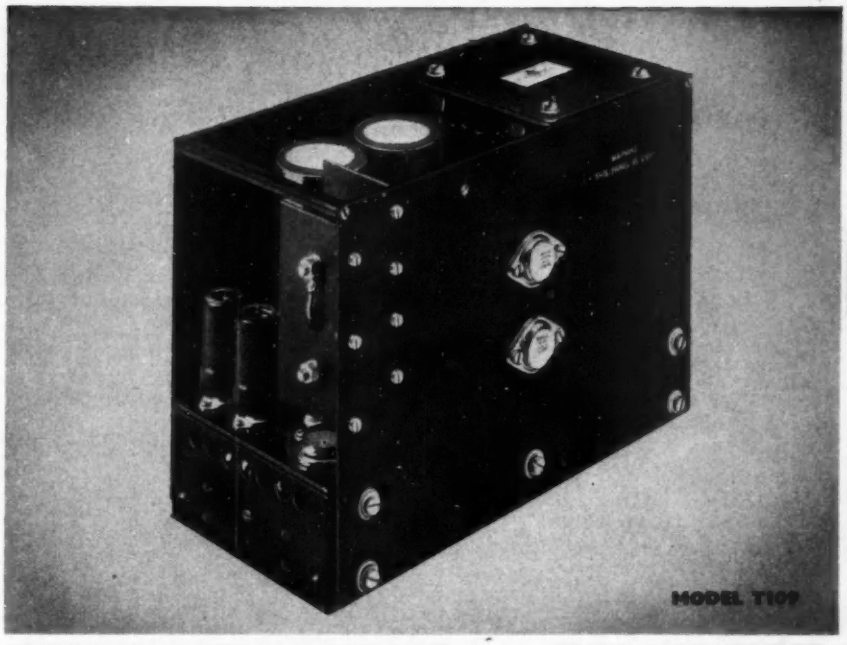

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T100	30 max.	1·0	0·04	0·1	1·0	7½	4½	5⅝	5½	45	0	0
T108	50 max.	1·0	0·1	0·1	1·0	8½	5½	6½	8	55	0	0
T109	50 max.	2·0	0·05	0·1	1·0	10⅜	5½	7½	13	70	0	0
T110	30 max.	5·0	0·01	0·1	1·0	13½	8½	7⅜	23	98	0	0
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T102	0–30	2·0	0·05	0·1	1·0	16¾	10¾	10¾	30	100	0	0
T103	0–30	1·0	0·05	0·1	1·0	13½	10¾	9¾	19½	85	0	0
†T104	0–30	1·0	0·05	0·1	1·0	16¾	10¾	10¾	30	129	0	0
	0–30	1·0	0·05	0·1	1·0							
T105	0–50	2·0	0·05	0·1	1·0	16¾	10¾	10¾	30	118	0	0
T106	0–100	1·0	0·1	0·1	2·0	*21½	14½	11¾	46	149	0	0
T107	0–100	2·0	0·1	0·1	2·0	*21½	14½	11¾	60	183	0	0
T111	0–50	5·0	0·01	0·1	2·0	*21½	18½	11¾	64	155	0	0
T112	0–50	10·0	0·01	0·1	2·0	*21½	20½	13½	101	245	0	0
T113	0–30	20·0	0·01	0·1	2·0	*21½	21	16½	139	315	0	0

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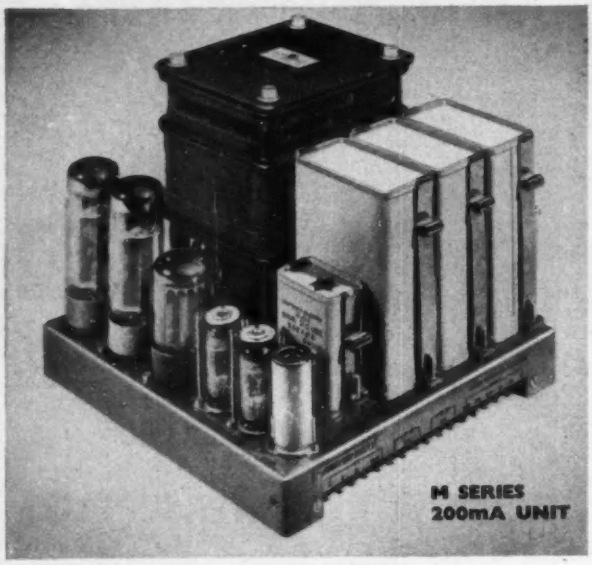
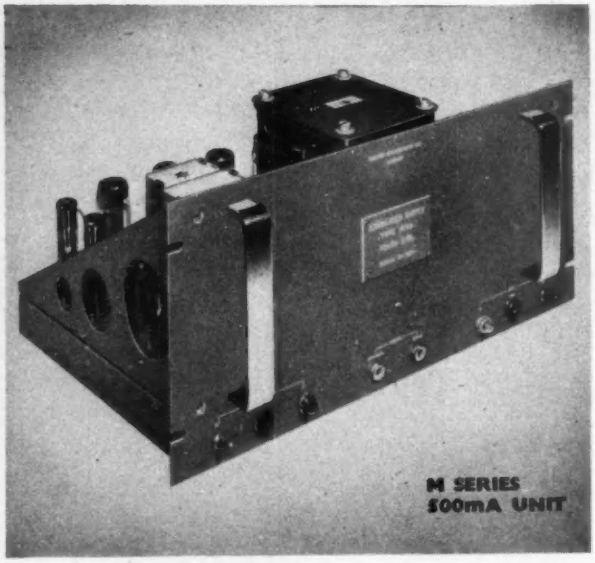




ROBAND

VACUUM TUBE REGULATED

MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L	X D	X HT.	WEIGHT IN LBS.	EX-WORKS £	S.	D.
M SERIES OPEN CHASSIS UNITS (Mains 200/250V A.C. 115V models also available)													
M22	150	0–20	Nil	0·1	0·02	1·0	4¾	3¾	4¾	2½	26	0	0
M22A	200	0–20	Nil	0·1	0·02	1·0	4¾	3¾	4¾	2½	26	0	0
M23	150	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M23A	200	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M33	250	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M33A	300	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M14A	100	0–100	3 & 3	1·0	0·02	1·0	10⅜	7	6½	14½	63	0	0
M24	150	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33	10	0
M24A	200	0–100	3 & 3	0·1	0·02	1·0	7⅜	6¾	6½	12¾	33	10	0
M34	250	0–100	3 & 3	0·1	0·02	1·0	7⅜	6¾	6½	12¾	33	10	0
M34A	300	0–100	3 & 3	0·1	0·02	1·0	7⅜	6¾	6½	12¾	33	10	0
M25	150	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M25A	200	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M35	250	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M35A	300	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M26S	150	30–500	5 & 5	0·1	0·02	1·0	14	11½	8	20	88	0	0
M26SA	200	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M36S	250	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M36SA	300	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M28	150	30–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M28A	200	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M38	250	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M38A	300	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M SERIES FRONT PANEL UNITS (Mains 200/250V A.C. 115V models also available)													
M26	150	30–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M26A	200	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M36	250	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M36A	300	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M27	150	50–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M27A	200	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M37	250	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M37A	300	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M29	150	100–2·0A	5 & 5	0·1	0·C2	1·0	19	18	10½	82½	255	0	0
M29A	200	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0
M39	250	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0
M39A	300	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0

All C.T.

B SERIES

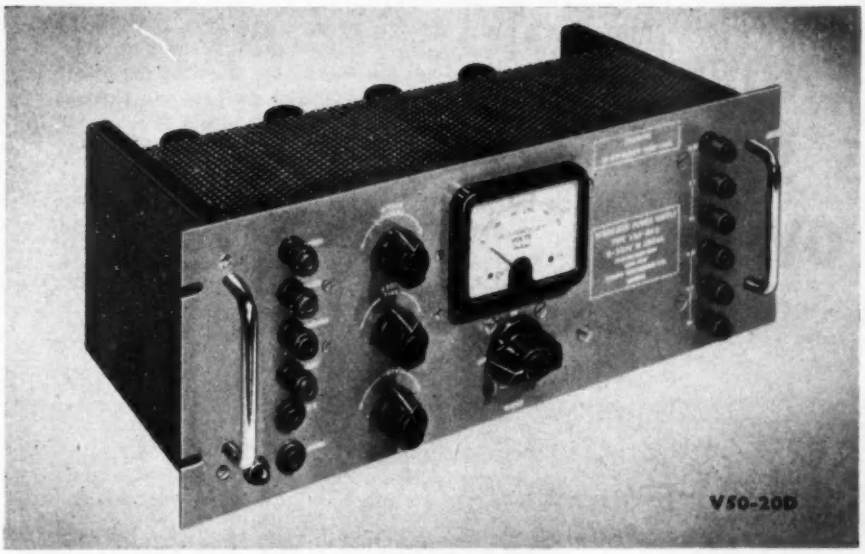
Rugged reliable units

Probably the most advanced series of open chassis units available today and characterised by an extremely rugged construction and a line-up of inter-services approved reliable valves. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) and a mains selector panel is included.

A compact welded rectangular framework of extruded angle aluminium alloy rigidly secures the 'C' core transformer and the 14 S.W.G. chassis housing the electronic sub-assembly. Because all the vulnerable components are located within the framework the risk of accidental damage is greatly minimised.

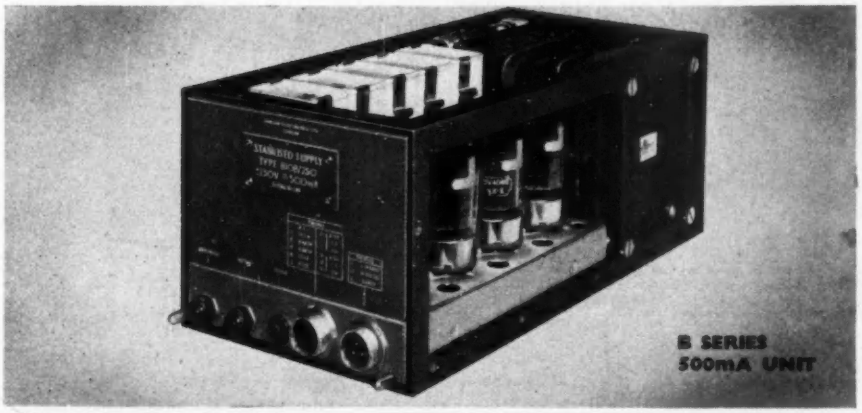
The framework contains anchor nuts which facilitate mounting the units in a variety of ways. It is permissible, for instance to secure any two units side by side to a standard 19" x 7" front panel.

High efficiency silicon junction rectifiers, series valves operating as pentodes and a 'C' core transformer to H2 specification ensure a minimum temperature rise within the unit. Insulated carbon and vitreous wire-wound resistors are used throughout and the conservative design permits continuous operation at full load even when the mains are permanently ±10% from nominal.



POWER SUPPLIES

ROBAND



MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS (IN AMPS. (ALL 6·3V))	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L × D × HT.	WEIGHT IN LBS.	EX-WORKS £ S. D.
B SERIES RUGGED RELIABLE UNITS (Mains 200/250V A.C. & 100/125V A.C.)									
B101/150	150	30–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/200	200	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/250	250	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/300	300	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/350	350	0–100	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B102/150	150	30–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/200	200	0–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/250	250	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/300	300	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/350	350	0–200	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B103/150	150	30–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/200	200	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/250	250	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/300	300	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/350	350	0–400	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0

— ALL C.T.

M SERIES

Open chassis units

Since their introduction some years ago, these chokeless supplies have firmly established their superiority over more conventional circuits.
Their smaller size—excellent high frequency performance and stable operation down to at least 1 c.p.s.—reliability at elevated temperatures and safe operation for ±10% mains changes—coupled with the highest engineering standards confirm the "M" Series as the first choice in stabilised units.

Front panel units

The front panel units have been designed for use with standard 19" racks. The panel is finished in B.S.S.632 grey (or any other colour at no extra cost) and houses the handles, mains and H.T. switches, fuses and indicator lamps. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) at the rear of the chassis.

V SERIES Regulated

variable voltage units

A range of regulated variable voltage supplies for use on the bench or standard 19" racks. Minimum weight and low internal heat dissipation are obtained by using chokeless circuits, 'C' core transformers, silicon junction rectifiers and series valves operating as pentodes.

V50-50. An exceptionally stable decade controlled 0 to 500V 500mA unit. A fixed 250V 50mA negative rail and two 6.3V 5A centre tapped windings are included.

The decade system enables the output to be changed incrementally with a much greater accuracy than that obtained by normal methods.

Price £137-10-0 ex-works

V50-20D. A 0 to 500V 200mA unit (restricted to 150mA below 200V) of moderate performance. A regulated variable negative rail from 0 to 85V via a 100K potentiometer and two 6.3V5A centre tapped windings are included. A coarse control varies the output from 0 to 500V in one continuous sweep and a fine control is included.

Price £69-10-0 ex-works

2V35-25. A very compact unit containing several regulated output voltages. There are two 0 to 350V 250mA sections (restricted to 150mA below 200V) which may be operated separately, in parallel or in series. Each section has a coarse control to vary the output from 0 to 350V in one sweep and a fine control is included. A fixed 250V 50mA negative rail and two 6.3V5A centre tapped windings are provided.

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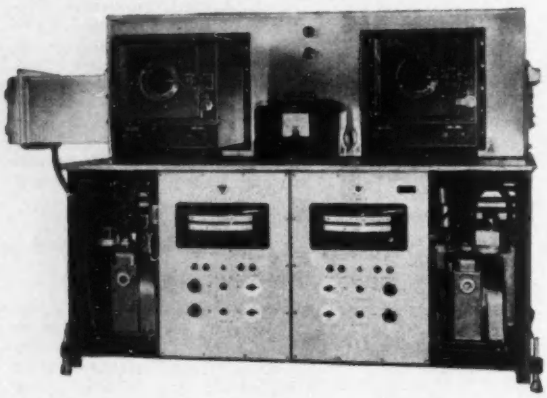

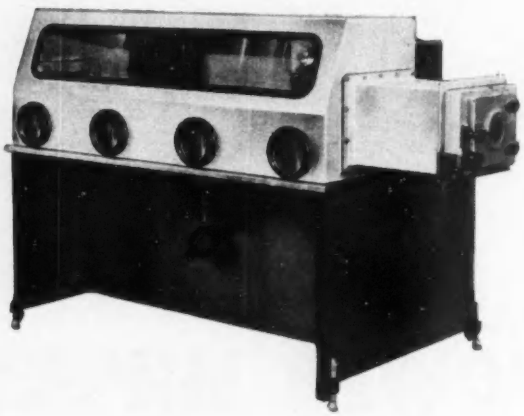

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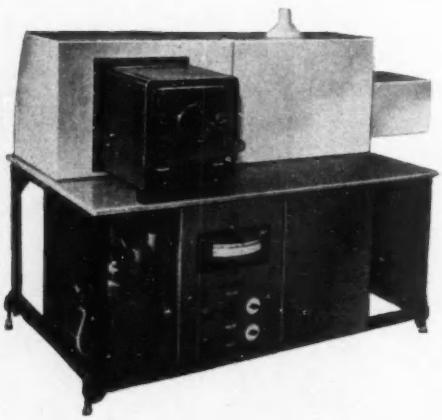

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Rectangular with self spacings to suit.
Double-ended controls.
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Temperature Range 0-400 C.
or equivalent F.

Temperature Control: Normal $\pm 7\frac{1}{2}$°C. Special ± 1°C.
Internal Spacing 7" x 8" x 18".
(can be altered to special requirements).
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2N 702	300	25	150	20-60	t_s 16nanosec.
2N 706A	300	25	200	20-60	t_s 25 nanosec.
2N 716	500	70	70	10-50	0.5W output at 70 Mc/s
2N 753	300	25	200	40-120	t_s 25 nanosec.
2N 760A	500	60	50	76-333	C_{ob} 5 mmf
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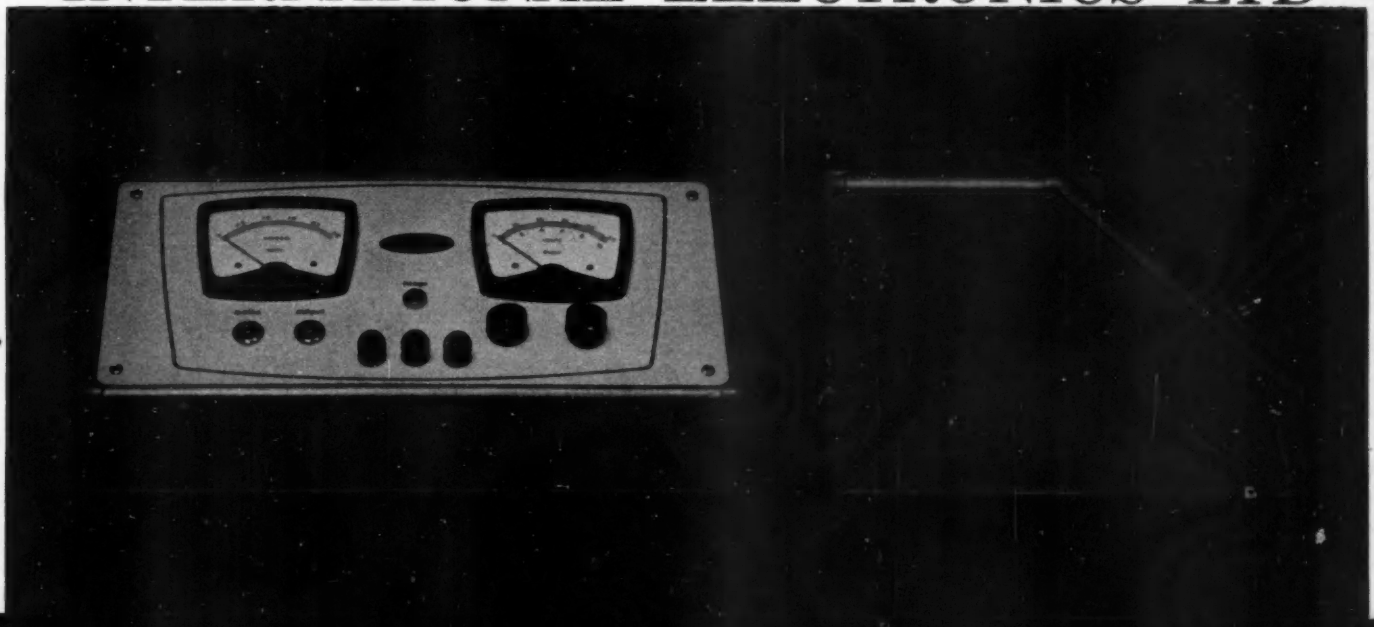

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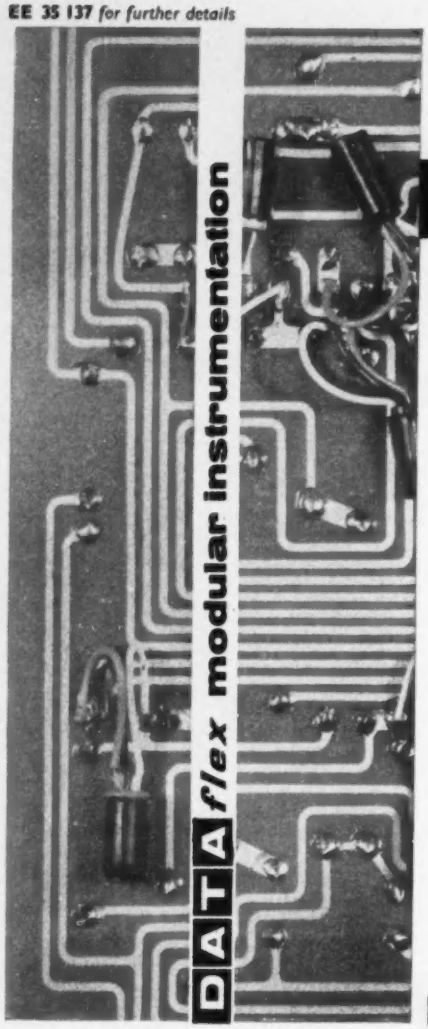

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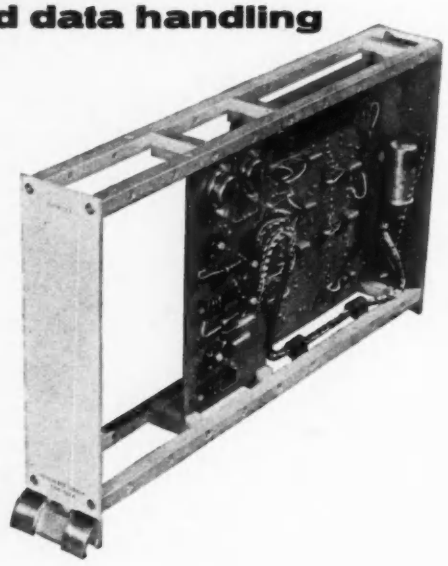

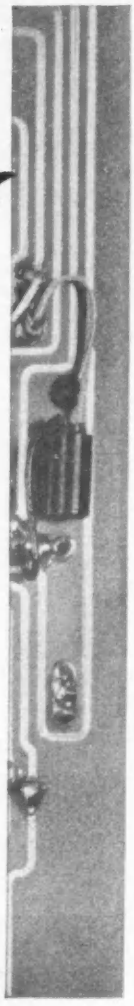

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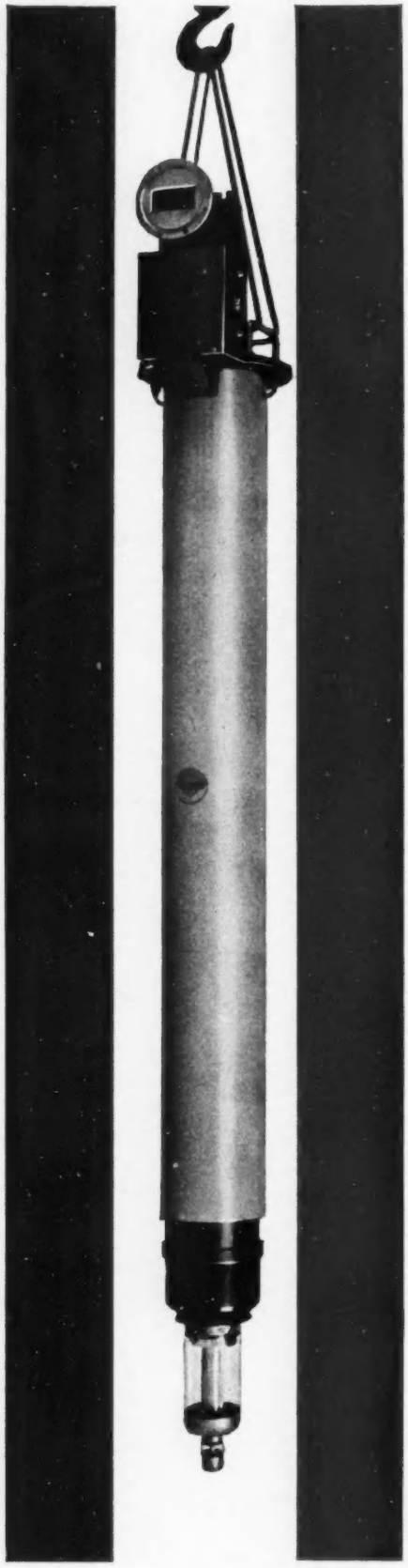

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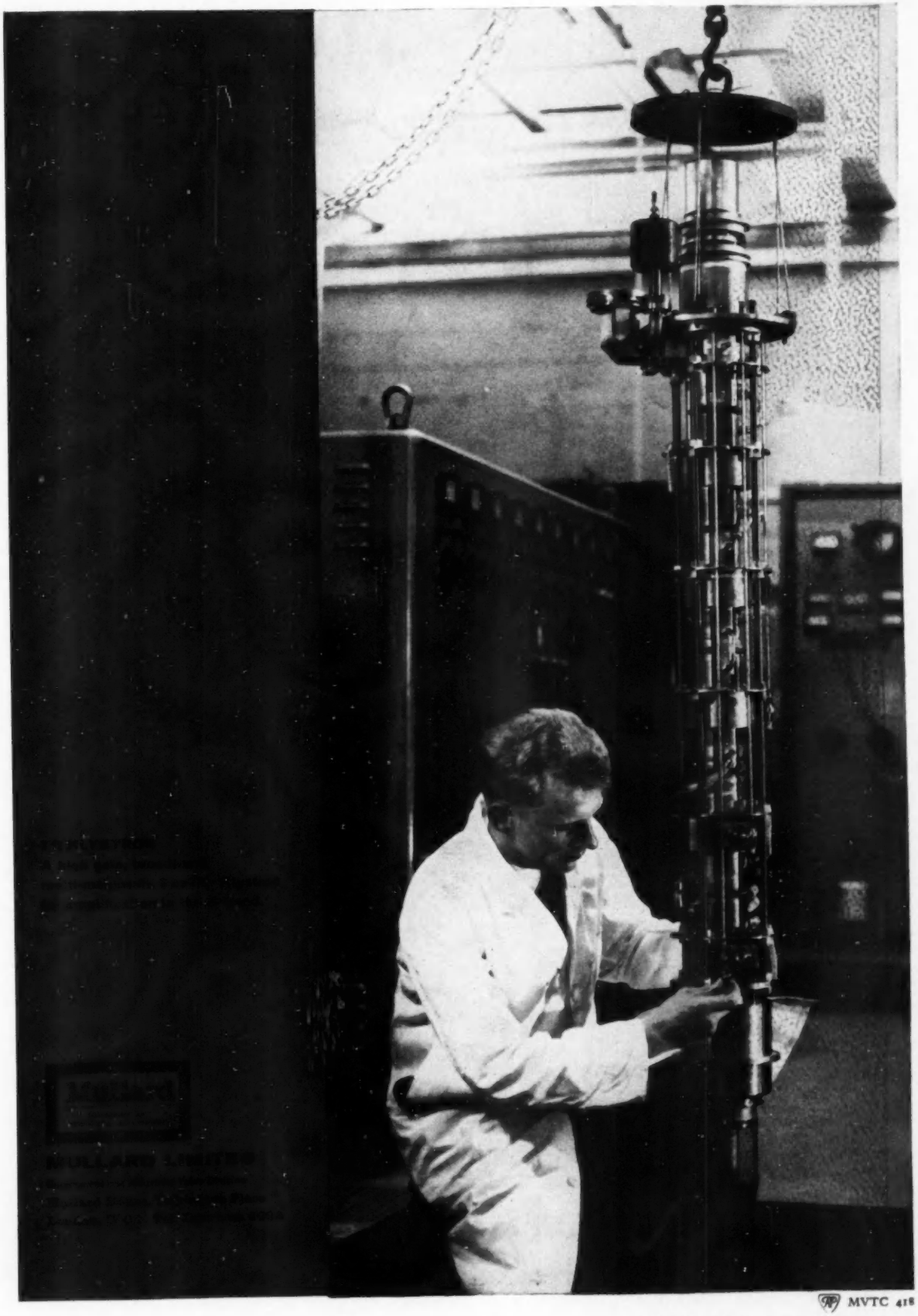
Disc Seal Triodes – Masers – Parametric Devices

Mullard experience in the microwave field is readily available to help you to select the right valve for your particular application. For details of the complete range of Mullard microwave valves, write to Mullard House quoting reference D4187.



MVTC 418

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The PATTERN of PROGRESS POINTS to

COLVERN

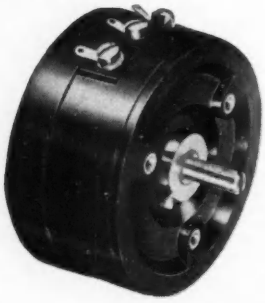
Wire Wound

POTENTIOMETERS

The search for greater accuracy is never ending and Colvern have for 30 years led the way in the development of Precision and Standard Wire Wound Potentiometers. The world's most extensive range by one manufacturer include Standard, Sealed Tropical, Helical and Sine/Cosine Types, many with Cam-Correction devices.

Illustrated is one of such 36 Basic Types.

TYPE CLR 7037
Sealed Tropical Potentiometers
Specification



RATING NOMINAL	12 watts
RESISTANCE RANGE/LINEAR	1Ω-150KΩ
NON-INDUCTIVE	20Ω- 40KΩ
SEMI-LOG	25Ω-100KΩ
RESISTANCE TOLERANCE	
Standard	±10%
Best Practical	±2%
SPINDLE (INSULATED)	Standard ¼" dia. (0.2475-0.2495)
FIXING	3-4 BA-1½ PCD
MAX. WORKING VOLTS SPINDLE/TRACK	1,000 V.D.C.
ANGLE OF ROTATION	
MECHANICAL	320° ±5°
EFFECTIVE	300° ±5°
OPERATING TORQUE oz./in.	1-10
END STOP TORQUE lb./in.	>10
MAX. GANGED SECTIONS	4

Expert advice on your particular problem from:

COLVERN Ltd., Spring Gdns., Romford, Essex, England

Tel: Romford 62222 PBX

Telegrams and Cables: COLVERN PHONE ROMFORD.

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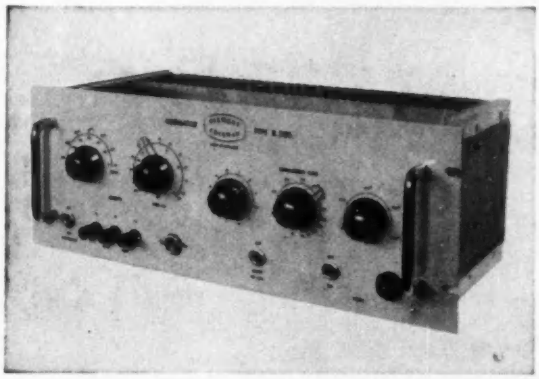
Oscillographic recording and testing equipment from Siemens Ediswan

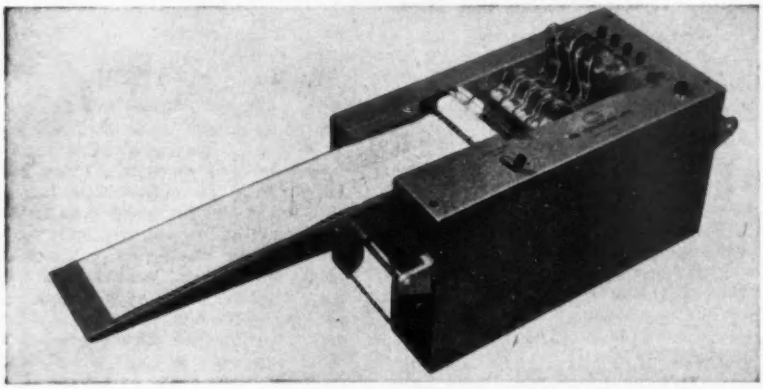
If your work involves the study of fluctuating or intermittent phenomena, you should know more about these instruments.
The versatile High Speed Pen Recorder unit can be supplied singly or grouped in multiples of four up to a maximum of 16 channels and suitable amplifiers having a sensitivity of 1μV/mm a.c. or 10 mV/mm d.c. can also be supplied. These combinations are already making permanent economical records in industrial, physiological and physical research.



LOW FREQUENCY OSCILLATOR TYPE R.2125

The Low Frequency Oscillator is a general purpose R.C. instrument designed for testing, calibrating and setting up amplifiers, recorders, and low frequency wave analysers.

Frequency Range	1 c/s to 132 Kc/s
Frequency accuracy	2%
Output	Balanced push pull, 50 volts p.p. maximum on open circuit.
Attenuator	5 x 20 dB steps plus 0—20 dB continuously variable.
Output Impedance	600Ω—0—600Ω

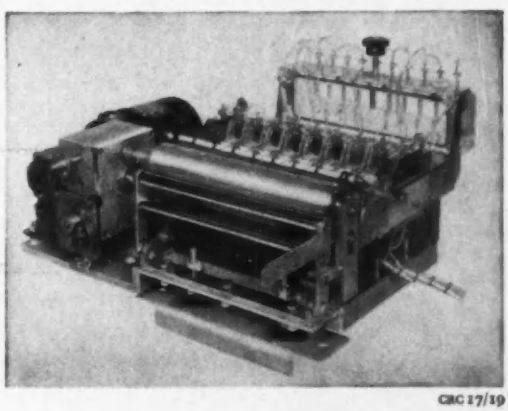


PORTABLE RECORDER TYPE EPR

The Siemens Edison Swan pen oscillograph is a portable 1 to 4 channel, high speed, direct ink writing, recorder.
The pen motor coil is 1450 ohms centre tapped.
Frequency response within 10% from 0–70 c.p.s.
Pen motors can be supplied with coil resistances of 230 ohms for use with transistors.
Maximum deflection of pen tip 4 cms peak to peak.
An electrical time and event marker is provided, writing on the lower edge of the paper.
The 4" wide paper is driven by a rubber covered capstan roller and speeds of 0·75 cms/sec. to 12 cms/sec. can be obtained.

8 CHANNEL PEN RECORDER UNIT

The pen motors incorporated in this unit are identical to those used in the 4 channel pen oscillograph. The unit includes 8 pen motors fitted into a magnet block, two time markers, ink system and paper drive mechanism.
Three speeds of 1·5, 3 and 6 cms/sec. are available.
The unit is offered as shown in the photograph and is intended for incorporation into the users own equipment.
A 16 channel version of the above unit is also available.



AEI

Associated Electrical Industries Ltd
Radio and Electronic Components Division
PD17, 155 Charing Cross Road, London, WC2
Tel: GERrard 9797. Telegrams: Sieswan Westcent London

CRC 17/19

EE 35 145 *for further details*

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more-exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	*PEAK THRUST*
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG108 Mk.II	5,300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables : Goodaxiom, Wembley, England

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GD659

4 NASHTON voltmeters

to Reduce Inspection and Test Costs in Laboratory and Production

TYPE	MODEL	RANGES			FREQUENCY	INPUT Z	ACCURACY OF F.S.D	PRICE
		VOLTAGE F.S.D.	CURRENT F.S.D	RESISTANCE				
V 11	AC/DC Valve Voltmeter	1, 3, 10, 30, 100, 300V, AC	-----	-----	50 c/s to 200 Mc/s.	1MΩ 3-4 pf	±3%	£47. 0. 0
		DC as for AC plus 1000V	-----	-----	----	10MΩ		
V 12	DC Valve Voltmeter Microammeter	1, 3, 10, 30, 100, 300 1000V, DC	0.1, 0.3, 1, 3, 10, 30, 100, μA	----	----	20MΩ balanced or 10MΩ unbalanced	±3% and 1% 24 hour stability	£81. 0. 0
V 15	Sensitive Valve Voltmeter	30, 100, 300mV 1, 3, 10, 30, 100, 300V, AC	----	----	40 c/s to 500 kc/s	3MΩ 35 pf	±3%	£49. 10. 0
V 17	Universal DC Meter	1, 10, 100 1000V, DC	0.1, 1, 10, 100, μA DC	10Ω to 1MΩ 4 ranges, 3V DC test potential	----	10MΩ for voltage 10MΩ to 1 KΩ for current	±2%	£80. 0. 0

The NASHTON Range — your requirements at a glance.

Look at the performance of these four NASHTON Voltmeters, then look at their prices—they are of outstanding value for money. But that's not all—they bring a new economy to production inspection and laboratory tests by speeding them up. They are designed for ease and simplicity of use and for rapid, mistake-free, repetitive readings under realistic working conditions. Invest in NASHTON accuracy at NASHTON Economic Engineering prices—speed up the vast bulk of your work by quick, dependable, time-saving readings.

TEXAS Instruments Limited use NASHTON Voltmeters in their Quality Assurance Department for Production Inspection.

NASH & THOMPSON LIMITED

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The Romans too had a word for it. . .

As a matter of fact, they had three words for it. So have we, but they are not the same. To the Romans, PARVALUX meant "Light But Little". To us, it means Fractional Horse-power Motors—and that is what it means to our numerous customers, organisations whose names are known the world over. And so, of course, the name PARVALUX is known all over the world, too. When we are asked to build a machine, years of skill and craftsmanship go into its construction. That is why intricate specifications never worry us. We also have a very extensive range of standard f.h.p. motors and gear units, with horsepowers varying from 1/300 to 1/5, yet even these can be modified to suit any customer's special requirements. If PARVALUX also meant "versatile", we should not be at all surprised.

Fractional Horse-power Motors by...

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PARVALUX
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to meet YOUR need exactly
T.M.C.'s extensive range includes low-priced capacitors for run-of-the-mill uses as well as those for top-quality precision work. Here are some of the applications for which T.M.C. capacitors are being so widely used:
RADIO AND TV EQUIPMENT · ELECTRONIC EQUIPMENT
COMPUTERS · TELECOMMUNICATIONS · FILTERS · RADAR
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POWER FACTOR CORRECTION · PHASE SPLITTING
ENERGY STORAGE
Capacitance Tolerances from 0.1%
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Whatever *your* need, you'll find that the ideal capacitor is made by T.M.C. whose knowledge, experience and technical resources will be placed at your service if you write for further information.

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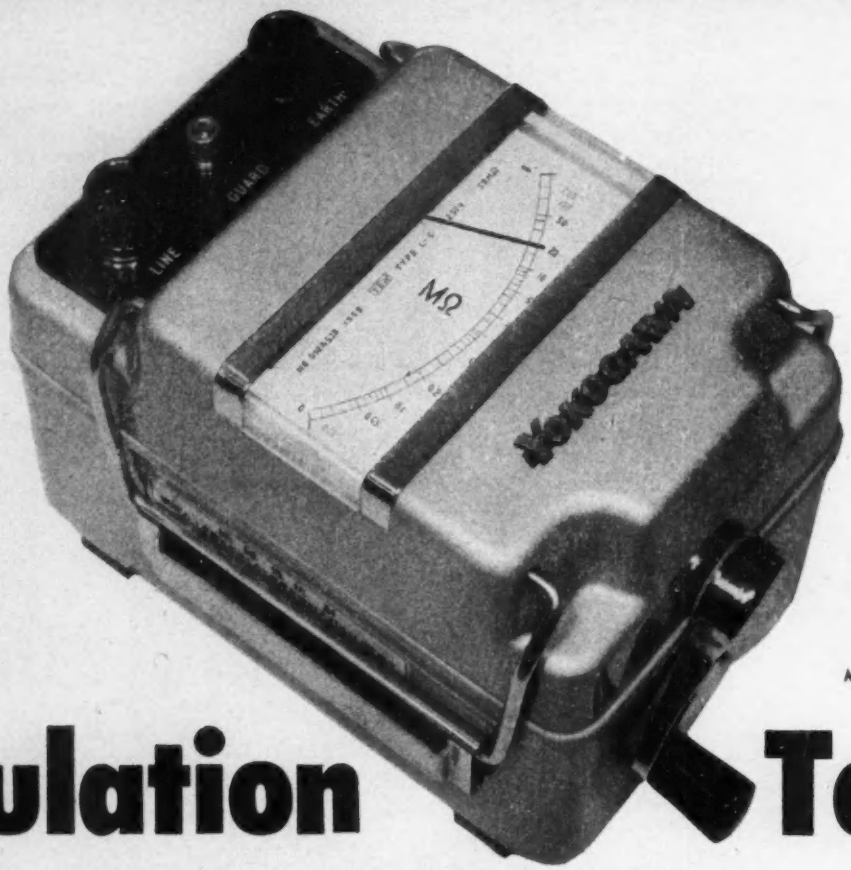


Model L-5

Insulation Tester

EXPANDED SCALE YEW Model **L-5** has a long and electrically expanded scale which covers 5 decades of resistance.

QUICK RESPONSE The quick response of Model **L-5** will help you read the insulation resistance instantly.

SILENT GENERATOR The rotary magnet type generator turns extremely smooth and silent because of its excellent dynamic balance.

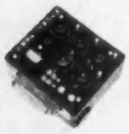
CORE MAGNET SYSTEM INDICATOR The indicator employs a core magnet system in which the yoke acts as a self-shield to minimize the external field influence.

GOOD DESIGN YEW Model **L-5** has a graceful appearance with gray colored aluminum case with a wide window.

Rated Voltage/ Rated Resistance	Range			Effective Measuring Range
100V / 20M Ω	0~∞ Ω	Lowest scale line Highest scale line	2k Ω 100M Ω	0.02~20M Ω
250V / 50M Ω	〃	〃 〃	0.01M Ω 200M Ω	0.05~50M Ω
500V / 100M Ω	〃	〃 〃	0.01M Ω 500M Ω	0.1~100M Ω
500V / 1,000M Ω	〃	〃 〃	0.1M Ω 5,000M Ω	1~1,000M Ω
1,000V / 2,000M Ω	〃	〃 〃	0.5M Ω 10,000M Ω	2~2,000M Ω

Portable Instrument

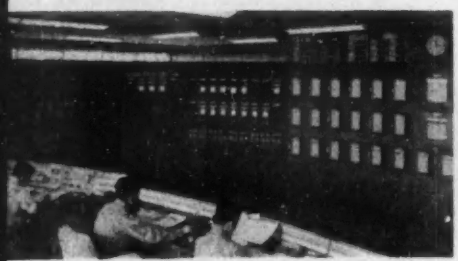
Panel Instrument

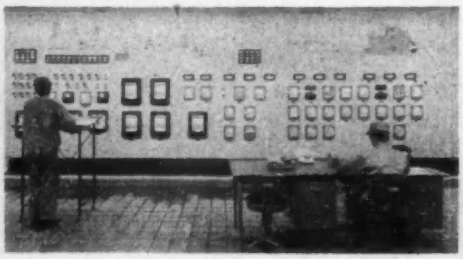

Wheastone Bridge

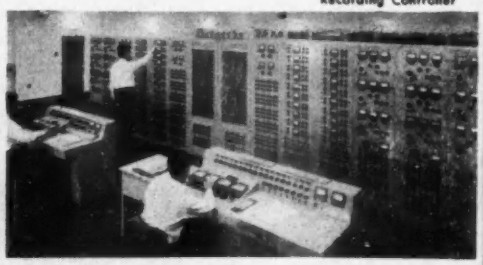
Circuit Tester

Q-Meter

All Electronic Recording Controller


Economic Load Dispatch Computer


Central Control Station of Chemical Plant


All Electronic A.C. Network Analyzer

YOKOGAWA ELECTRIC WORKS, LTD.

YEW

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U. K. Sales Agents for Insulation Testers: THE ELECTRICAL INSTRUMENT CO., LTD., Boswell Square, Industrial Estate, Hillington, Glasgow, S.W. 2

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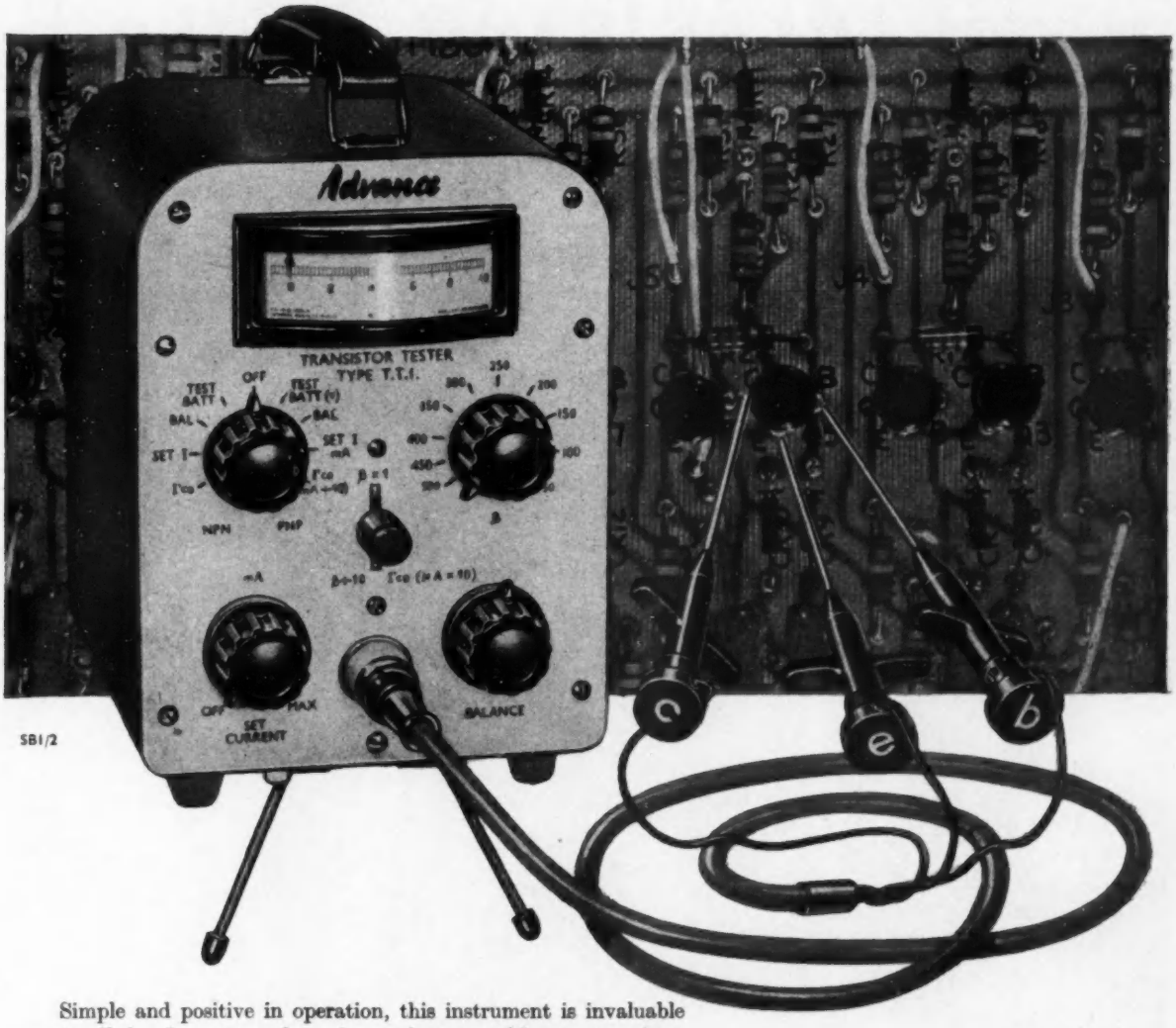
why disconnect ?

Transistors can be tested in circuit with the Advance TRANSISTOR TESTER Type TT1.



SB1/2

Simple and positive in operation, this instrument is invaluable to all development and service engineers working on transistor circuits. It is unusually compact and completely independent of external power supplies. By means of the special clip-on probes provided, the β current gain of both p.n.p. and n.p.n. transistors can be measured *without disconnecting the component from the circuit.*

Designed and engineered in the Advance tradition, the TT1 is a worthy addition to the Company's comprehensive range of test instruments and equipment.

- TESTS N.P.N. AND P.N.P. TYPES.
- BETA RANGE 5 TO 500.
- LEAKAGE CURRENT MEASUREMENTS (OUT OF CIRCUIT).
- BATTERY OPERATED TRULY PORTABLE.
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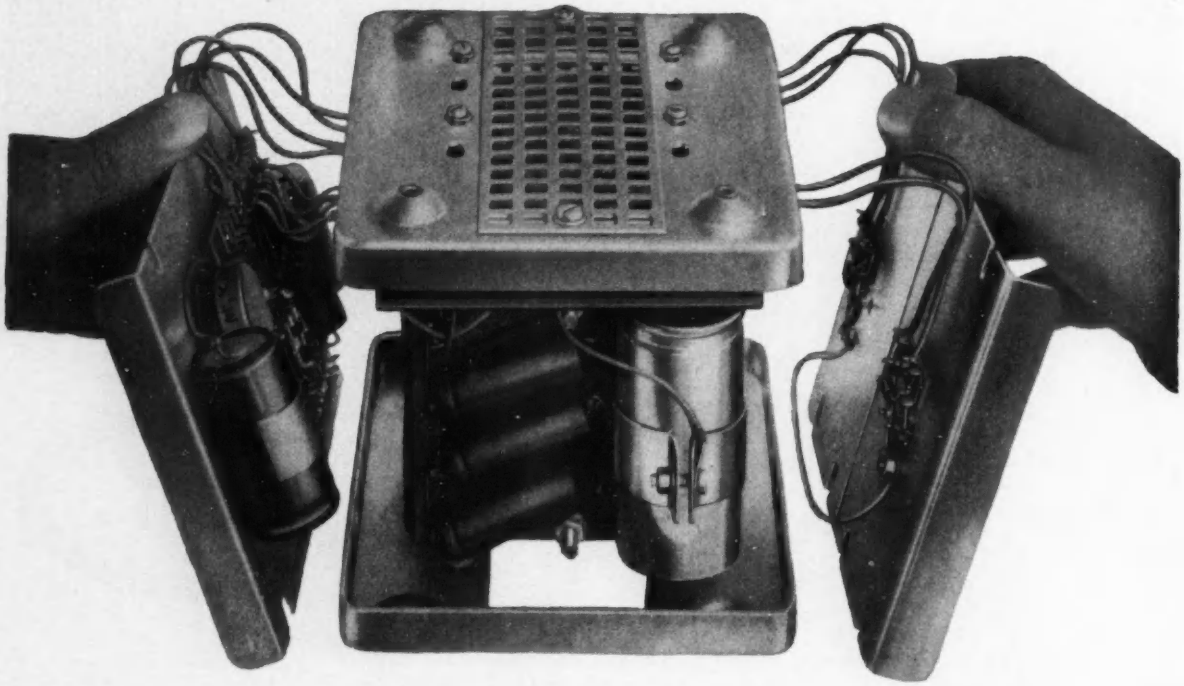
Low in cost - Highly flexible

TRANSISTOR P.S.U.s

Here is the most economical and convenient method of obtaining low voltage power supplies to meet differing production or laboratory requirements.

Mullard Equipment Limited has produced a range of P.S.U. sub-assemblies, consisting basically of four simple units which, readily added one to another in building brick fashion, will provide power from 1 to 39 volts. And they will do this most economically. A 1 amp stabilised supply need cost only £25.



The four basic units are:—

- ✳ **1 amp Unstabilised Unit (YL. 6101)**
- ✳ **5 amp Unstabilised Unit (YL. 6102)**
- ✳ **250 mA Stabiliser and Reference Section (YL. 6103)**
- ✳ **Series Regulator Section (YL. 6104)**

Constructed for easy assembly, the basic units may be duplicated in operation for higher power applications.

These P.S.U.s are ideally suited for use in equipments and systems employing other Mullard Equipment sub-assemblies such as the well-known Norbits and Combi-Elements.

For further details please write, quoting reference D/675/7, to:

MULLARD EQUIPMENT LIMITED

Mullard House • Torrington Place • London WC1 • Tel: Langham 6633

ME 675

THINNER THAN EVER!

BECOMING STILL THINNER

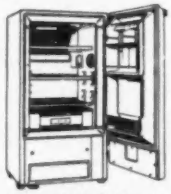
Sanyo Electric Co., Ltd. now announces the achievement in dramatically reducing thickness of *thermo module* element down to 2/3 of others, without sacrificing its performances in any way. Our exhaustive study reveals possibility of still reducing its thinness for applying to limit installing space of scientific and electronics equipments.

SPECIFICATIONS

Type	Couple	Optimum Current (amp)	Optimum Voltage (volt)	T_h (1) (°C)	Insulation Voltage (volt) (2)	Dimensions mm (inch)
STM-1025	10	25	0.9	55	50	57×43×9.5 (2.24×1.69×0.374)
STM-1025V	10	25	0.9	55	1500	57×43×10.5 (2.24×1.69×0.413)
STM-1012	10	12	0.9	55	50	41×32.5×8.5 (1.62×1.28×0.334)
STM-1012V	10	12	0.9	55	1500	41×32.5×9.5 (1.62×1.28×0.374)
*STM-1006	10	6	0.9	55	50	36×29×6.5 (1.42×1.14×0.256)
*STM-1006V	10	6	0.9	55	1500	36×29×7.5 (1.42×1.14×0.295)

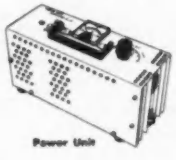
Subject to change without notice

Note: (1) No heat load T_h is 27°C
(2) Voltage applied between circuit and hot or cold plate.
* Being marketed soon.

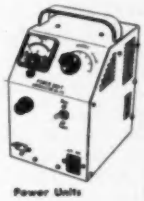


Thermo-electric Refrigerator

Thermo Electric Jar



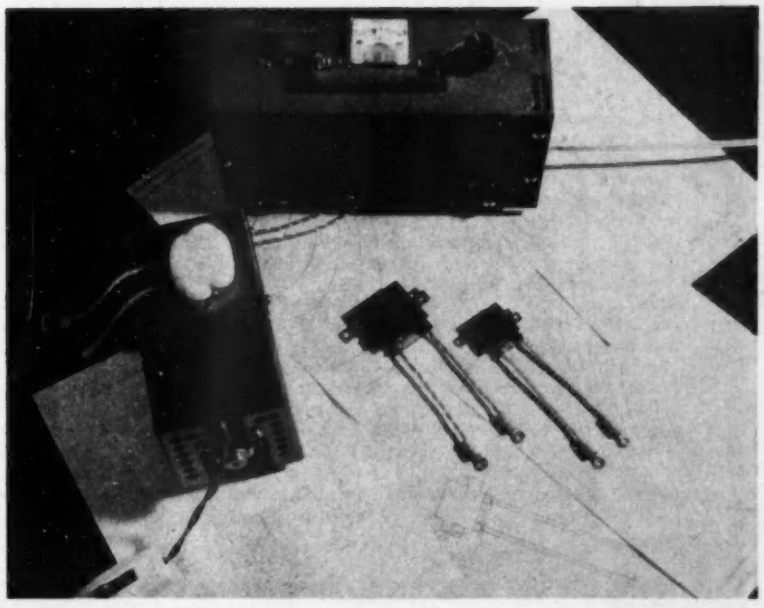
Power Unit



Power Units

Thermo Pot

Thermo Processing Tray



Apply for further details to:

SANYO

SANYO ELECTRIC CO., LTD. OSAKA, JAPAN
INTERNATIONAL DIVISION SANYO ELECTRIC TRADING CO., LTD.

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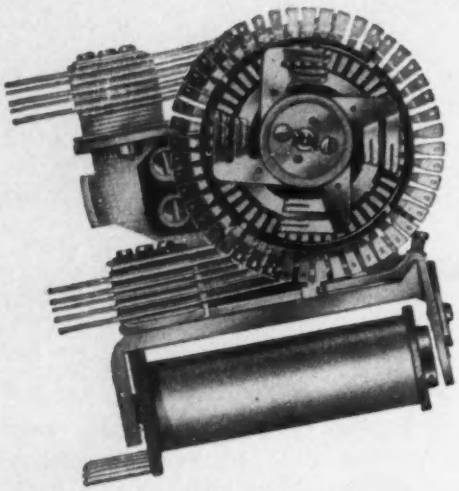
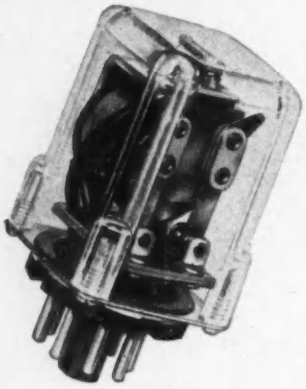
THORN RELAYS



THERMAL TIME DELAY RELAY ▶

◀ 3 IN 1 RELAY



PYGMY POWER RELAY ▶

THORN 3 IN 1 Stepping Relay . . . Rotary Switch . . . Relay . . . all in one, yet only slightly larger than a conventional relay!
1. STEPPING RELAY Ratchet driven with two cams which operate 2 c/o contacts on the 6th position of each switch quadrant, returning to normal on the 7th position.
2. ROTARY SWITCH Ratchet driven with four banks of twelve points each with bifurcated spring wipers. Transparent dust-cap fitted as standard.
3. STANDARD RELAY Knife-edge armature pivot operating 2 c/o and 1 n/o contacts.
Relay Contacts: to carry 1.0A or break 0.5A non-inductive at 50 V.D.C.
Switch Contacts: to carry 0.5A or break 0.1A non-inductive at 50 V.D.C.
Coil Voltages: 12, 24, 46, 60 and 110 volts D.C.
This unit has wide application in automation, counting and tallying operations, automatic test equipment, sequencing on memory storage, remote control and telemetering.

THORN PYGMY POWER RELAY Interchangeable relay for use in remotely controlled automation units .2 pole and 3 pole changeover contacts. Dust proof—transparent polystyrene cover. Plugs into standard I.O. and B.11A bases respectively. Only 4½ ozs . . . projection only 2″ above base. Mechanical life over 10,000,000 operations.
Switching current: 5 amps maximum at 250 volts. A.C. Maximum surge current: 10 amps.
Operate time: 8 milliseconds approx. Release time: 6 milliseconds approx.
Overall dimensions: 1¾″ square by 2 9/32″.
Coil voltage: 6, 12, 24, 42, 60, 110, 220 volts. A.C. and 6, 12, 48, 60, 110, 240 volts D.C.

THORN THERMAL TIME DELAY RELAYS. These are convenient for control purposes in communication, computors and automation. The relay may be heated with direct or alternating current, the heater resistance is rated for an output of 3-6 watts. With relays having a reduced pick-up time (3-12 secs.) the heater output may amount to 9 watts at maximum. This relay meets Mil. Specification R.57570 if requested. Contact arrangement: Normally open or normally closed single pole. Contact ratings: with A.C. circuits max. 300 V.A. max, contact voltage 380 V.A.C. Max contact current 2.5A. with D.C. circuit max 30 W, max contact voltage 30 V.D.C. max contact current 1.5A.
Pick-up time: range of adjustment in seconds: 3-12, 10-30, 25-60, 50-110, 100-200.
Heater Voltage: 3, 6.3, 12, 15, 24, 15 V.D.C. or A.C. other heater voltages are available.
Life Expectancy: 10^6 cycles at maximum rated current .2 x 10^5 cycles with 0.2A. 115 V.A.C. or D.C.

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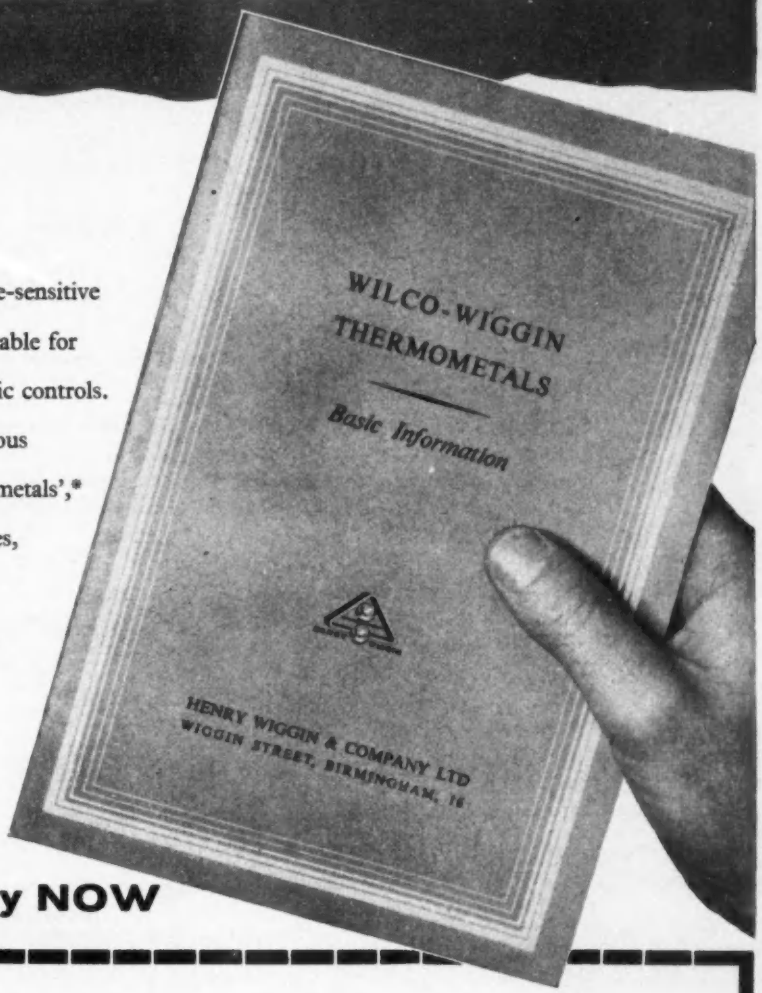
Thermometals



THERMOMETALS are temperature-sensitive bimetals produced in several grades suitable for use in a wide variety of thermostatic controls. This new publication describes the various grades of 'Wilco-Wiggin Thermometals',* with tables of thermal properties, design formulæ for various types of mechanism, and details of fabrication and heat-treatment.

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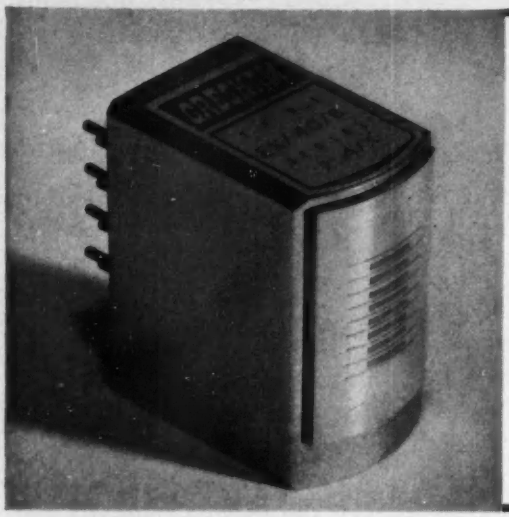

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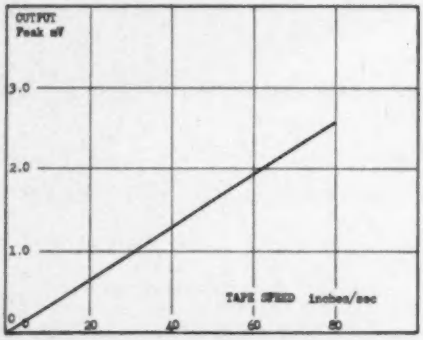
Type A/40/8/RP

IN LINE RECORDING HEAD
8 TRACKS ON ½ INCH WIDE TAPE
·040″ TRACK WIDTH

Particularly suitable for digital recording this head provides close packing density of tracks, at the same time giving wide track width to improve the signal to noise ratio and greater freedom from tape drop-outs. Having two coils per track separate feeds can be arranged to write positive and negative pulses on one track.

Height: 1.25 inches
Width: 0.7 inches
Depth: 1.3 inches (inc. terminals)
Track Width: 0·040 ± ·001 inches
Track spacing: 0·060 ± ·001 inches
Gap Length: 0·00025 ± 20% inches
Pole Length: 0·192 ± ·005 inches
Height of lower edge of bottom track from base: 0·477 ± ·001 inches
Azimuth, vertical to base: within ± ·0005 radians
Elevation, vertical to base: within ± ·001 radians
Inductance (2 coils in series): 3 milli-Henries ± 25%
Resistance (2 coils in series): 5 ohms ± 25%



Also available in this range are heads giving 4 tracks for ¼ inch tape and 16 tracks for one inch tape.

Gresham Lion Electronics Ltd. will be pleased to submit designs to suit any special requirement.

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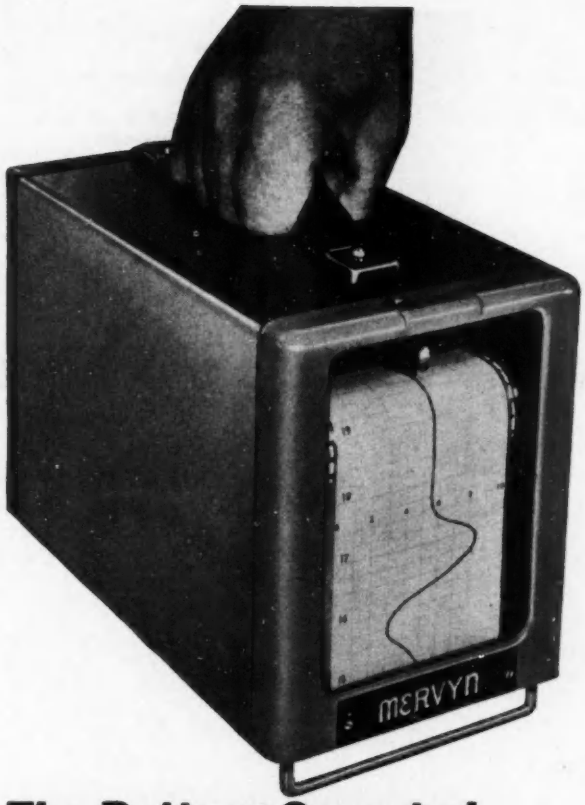

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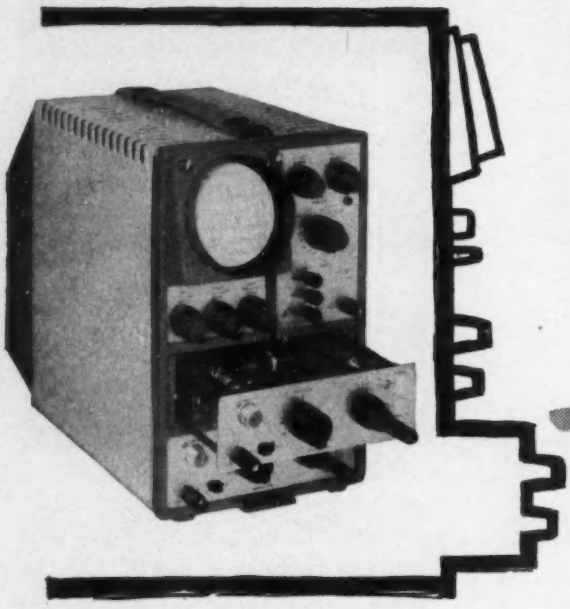
HIGH GAIN

INTERCHANGEABLE AMPLIFIERS



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A4 DIFFERENTIAL AMPLIFIER

This unit gives high gain; maximum sensitivity is 1mV/cm DC, frequency response 200 Kc/s.

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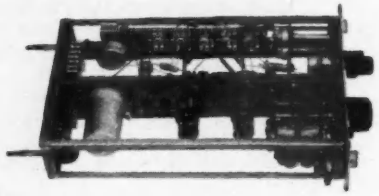
Maximum sensitivity is as high as 100 uV/cm AC, frequency response 5 c/s to 150 Kc/s.



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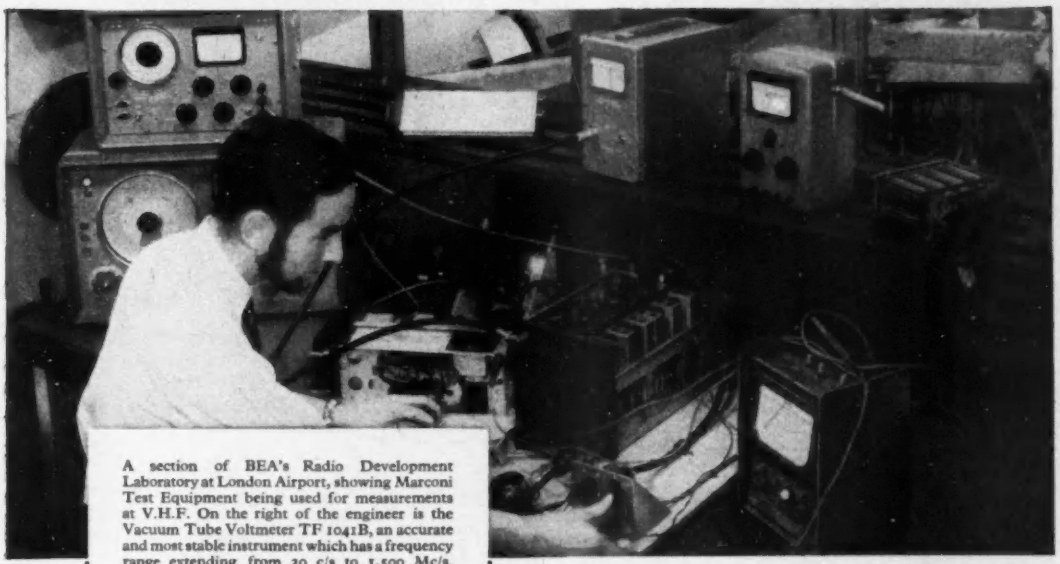

A section of BEA's Radio Development Laboratory at London Airport, showing Marconi Test Equipment being used for measurements at V.H.F. On the right of the engineer is the Vacuum Tube Voltmeter TF 1041B, an accurate and most stable instrument which has a frequency range extending from 20 c/s to 1,500 Mc/s. Measures: (i) a.c. up to 300 volts; (ii) d.c. up to 1,000 volts; (iii) resistance, 0.02 ohm to 500 MΩ. A.C. and D.C. multipliers available. For full details, please write for Leaflet J 195.

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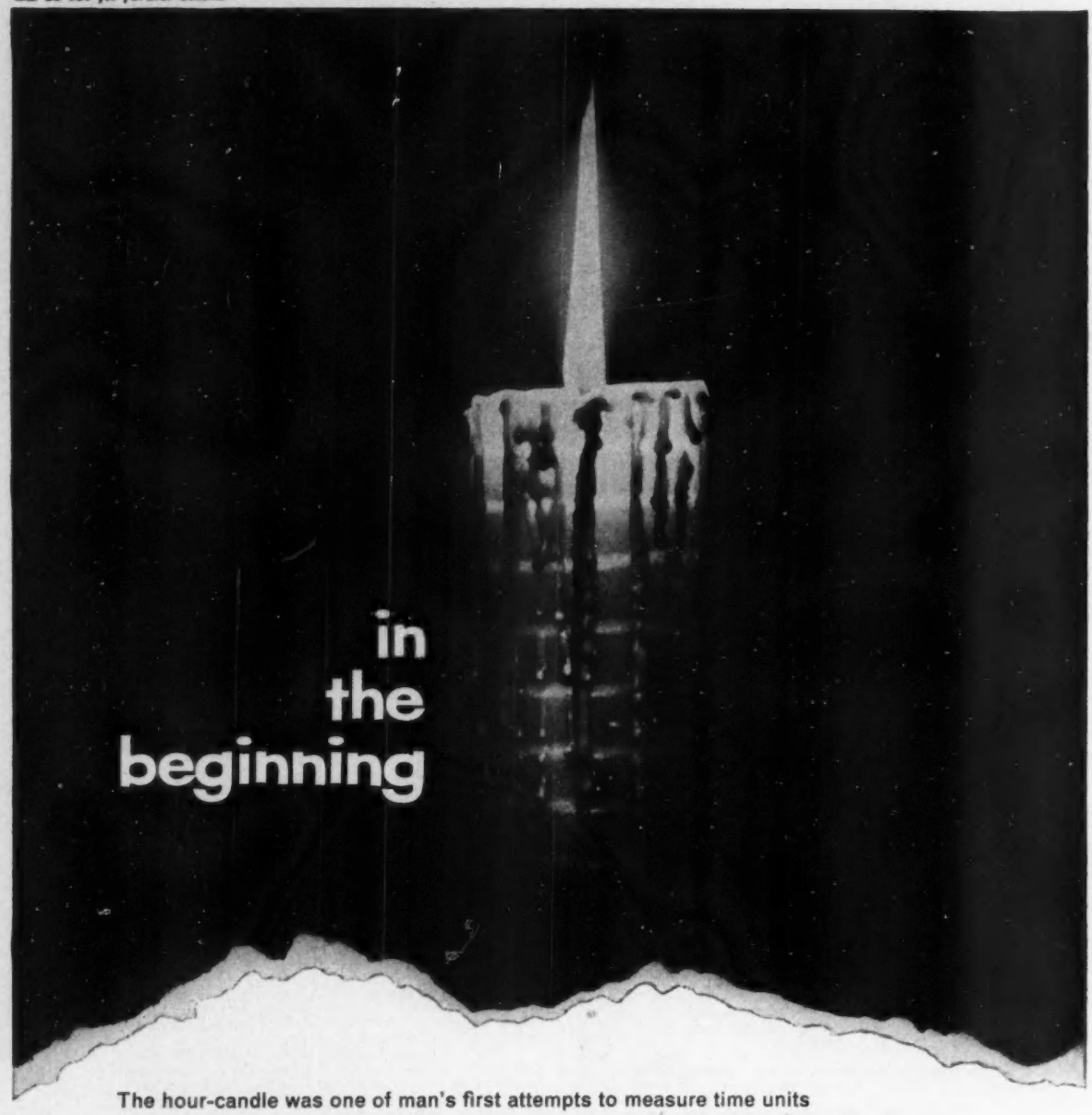

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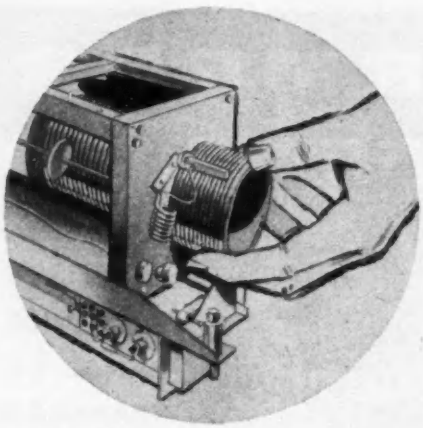

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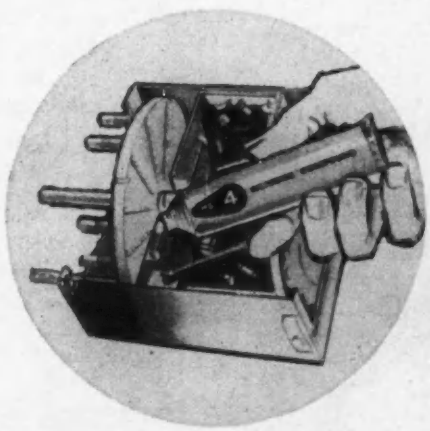
Write for detailed information on any one of the products mentioned here or for our new, illustrated booklet "Silicones in Electronics" (A 13).



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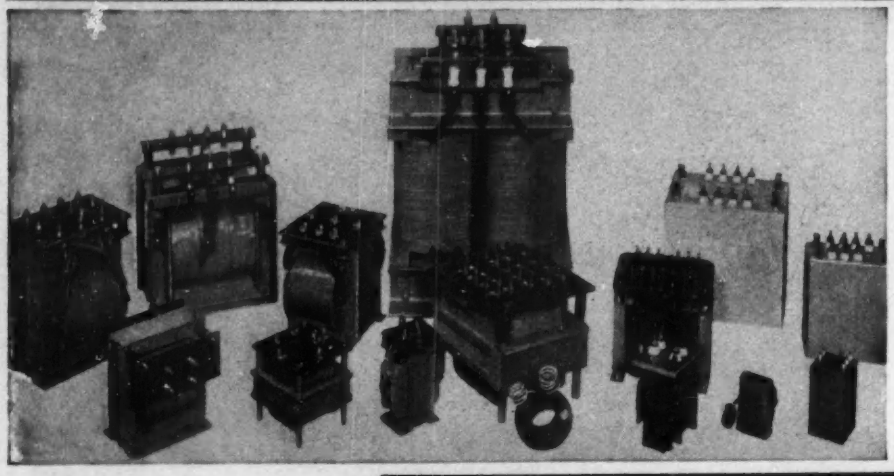

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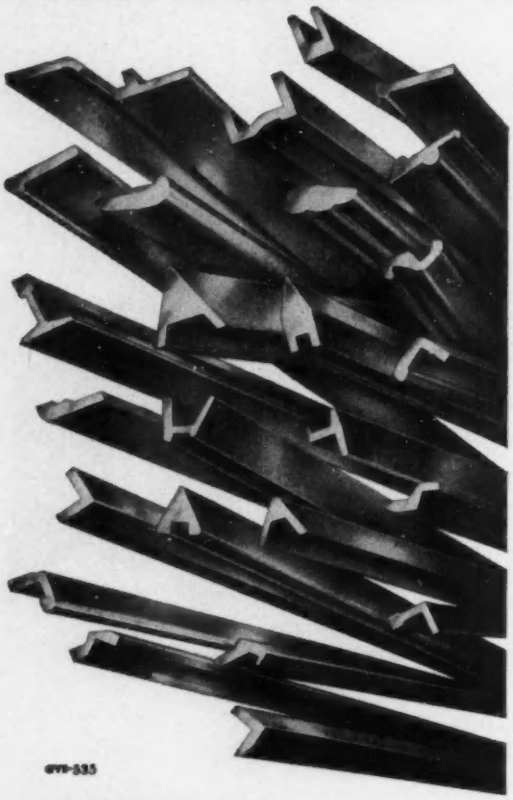

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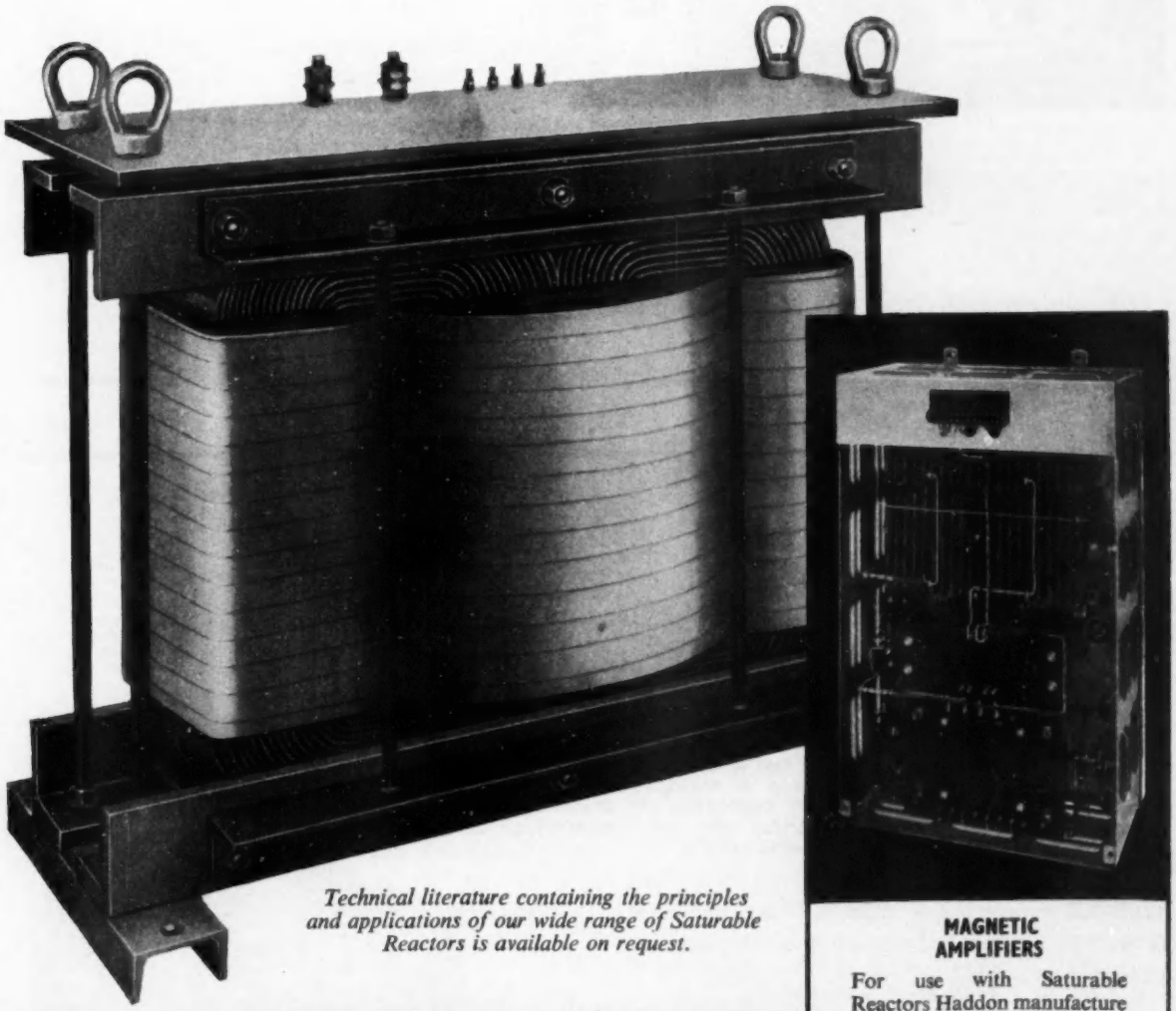

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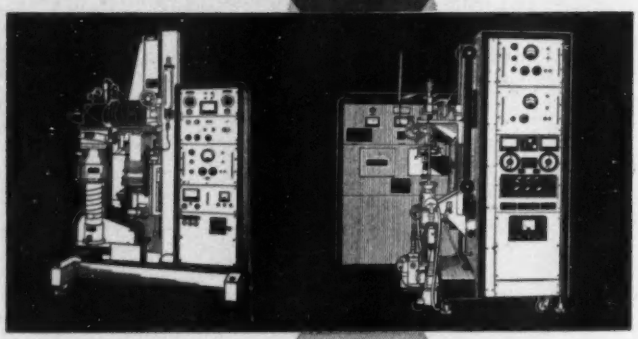

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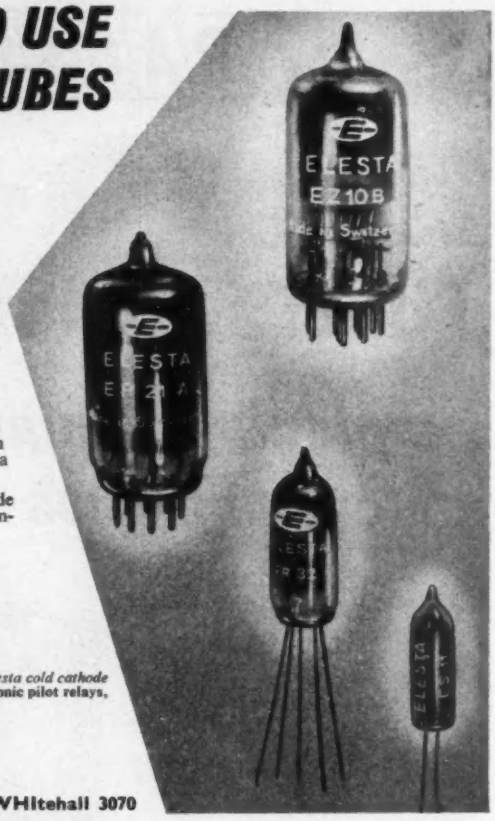

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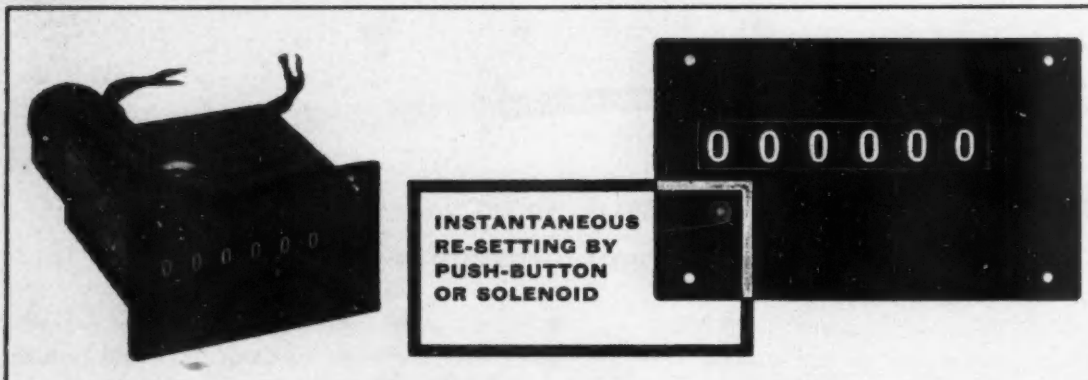

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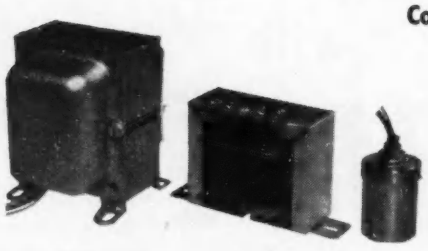

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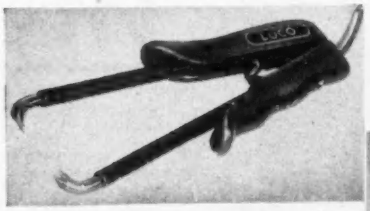

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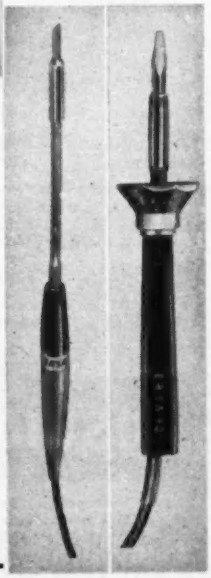

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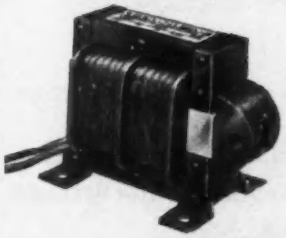

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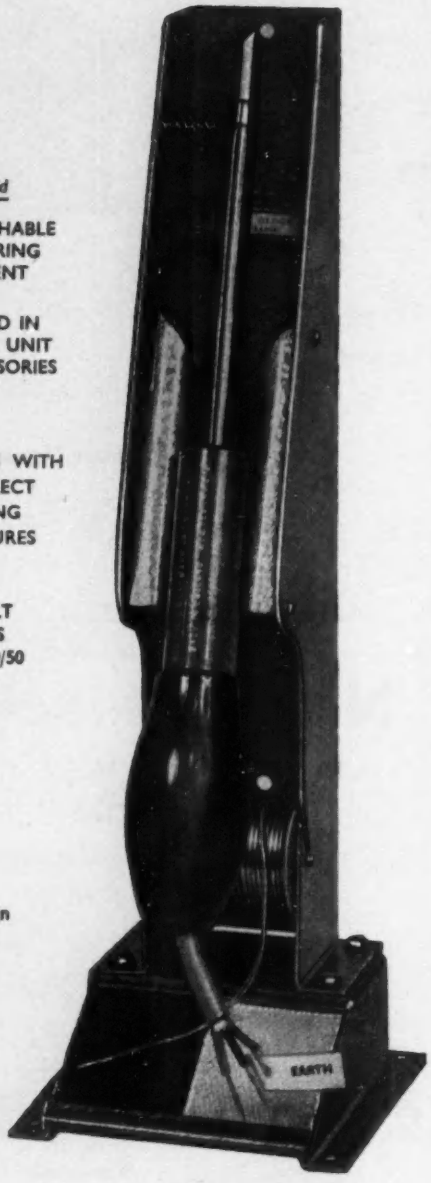

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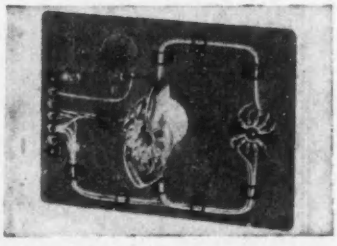

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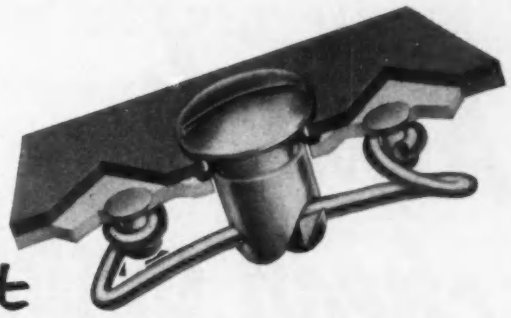

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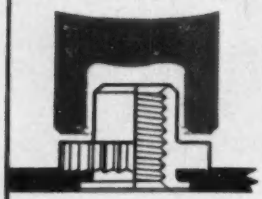

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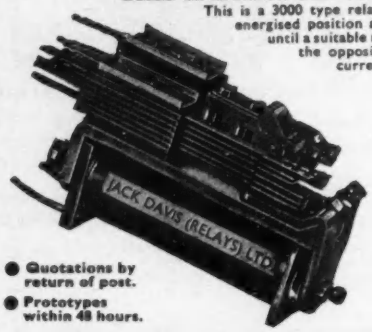

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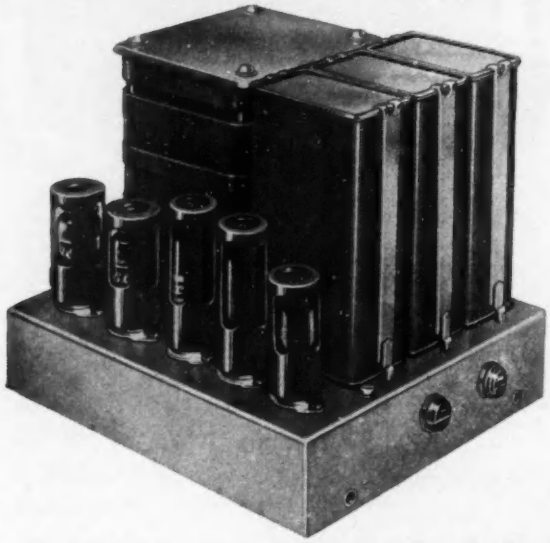

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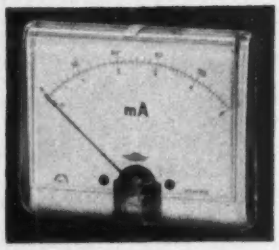

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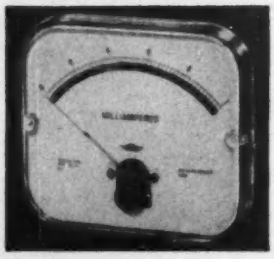

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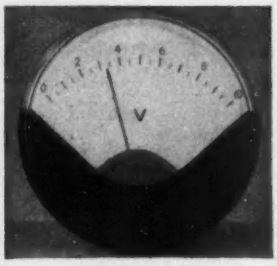

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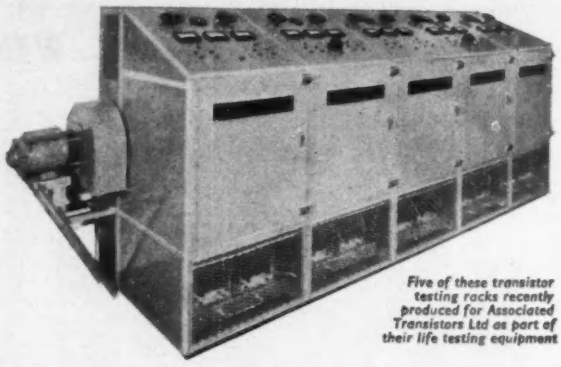

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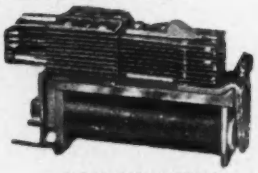

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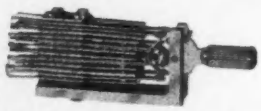

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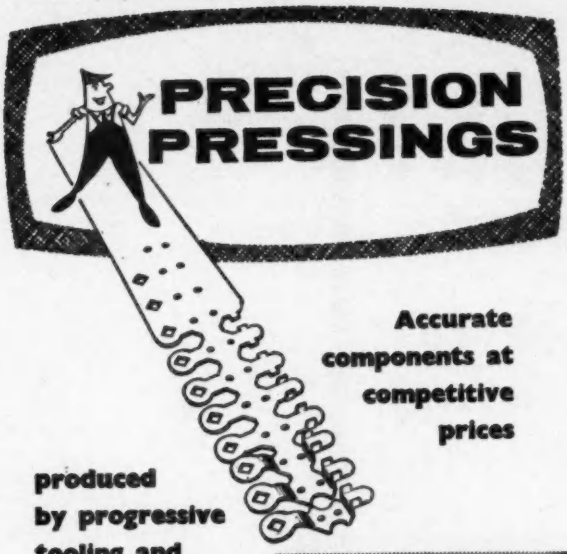

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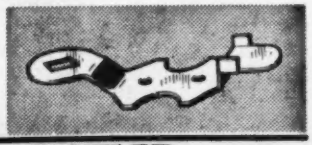

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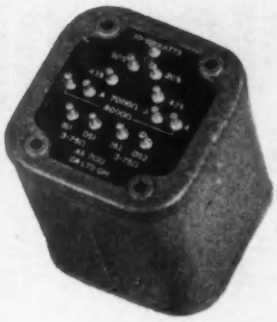

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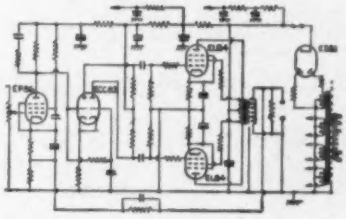

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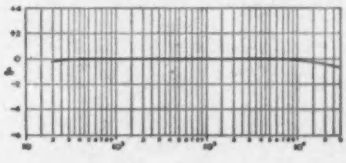
* This is one of twenty-two Audio Transformers in the Solent and Miniford series described in Gardners new leaflet "S/M", especially prepared for retailers and private users, which includes over a hundred standard Mains Transformers and Chokes. We shall be pleased to post you a copy upon request.

Below is reproduced the Response Curve of the AS.7012 which is typical of the whole of the Solent Series.



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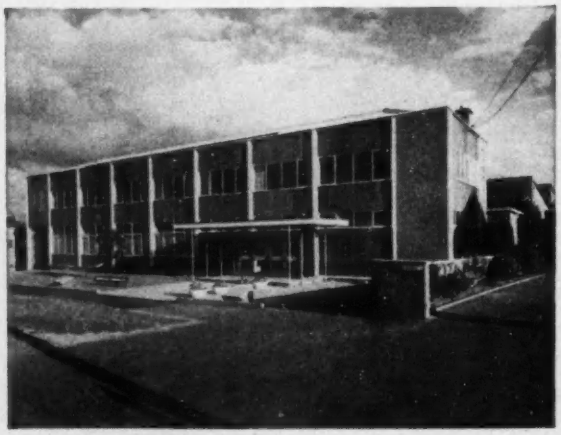

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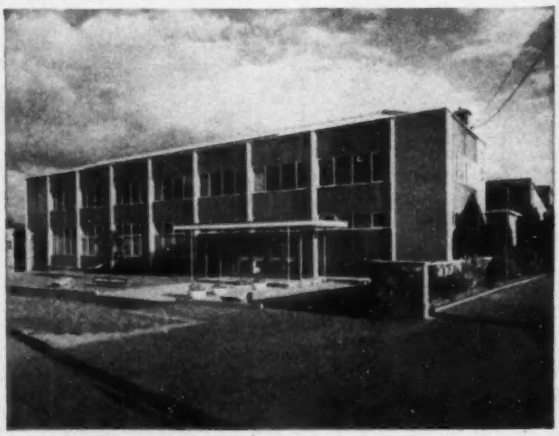

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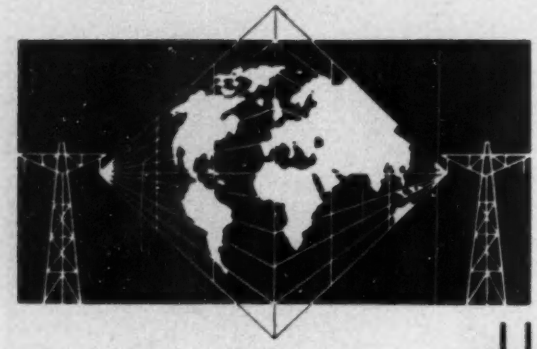

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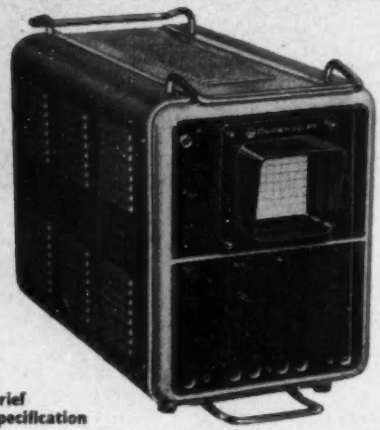

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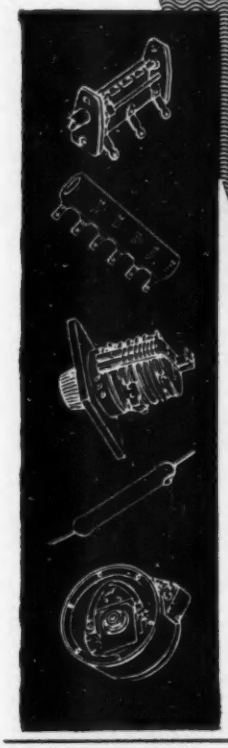

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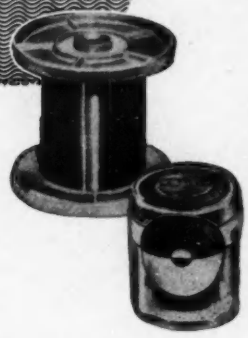

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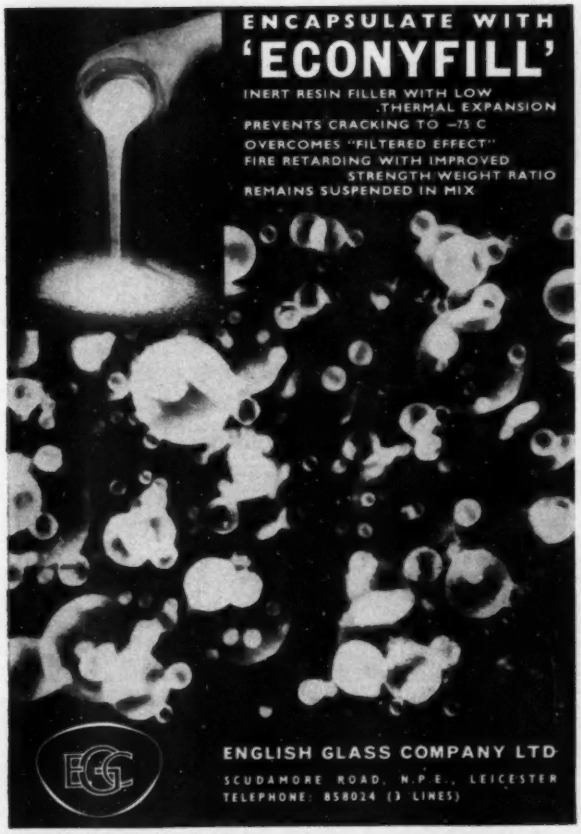
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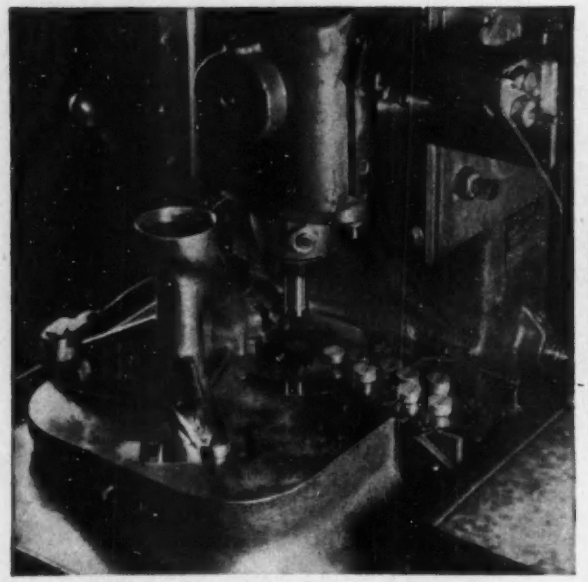

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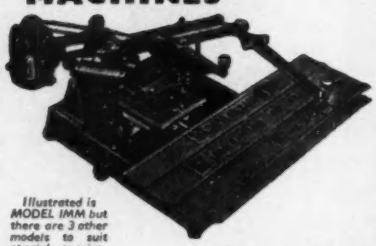

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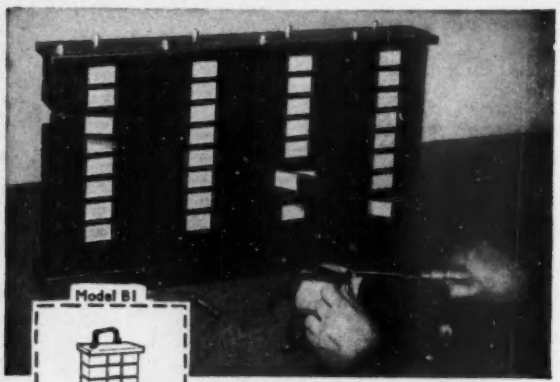

Model B1

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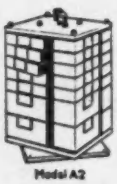

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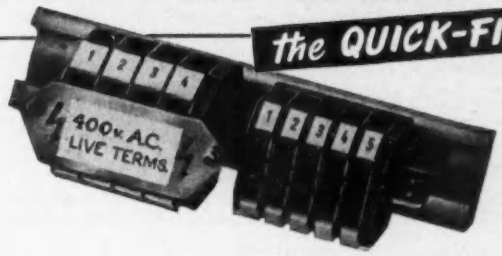

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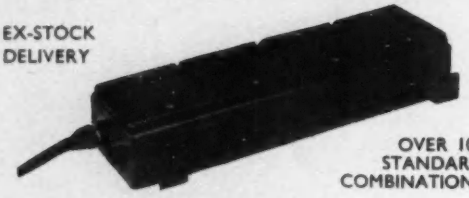

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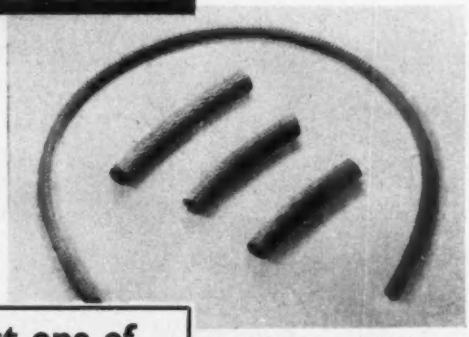

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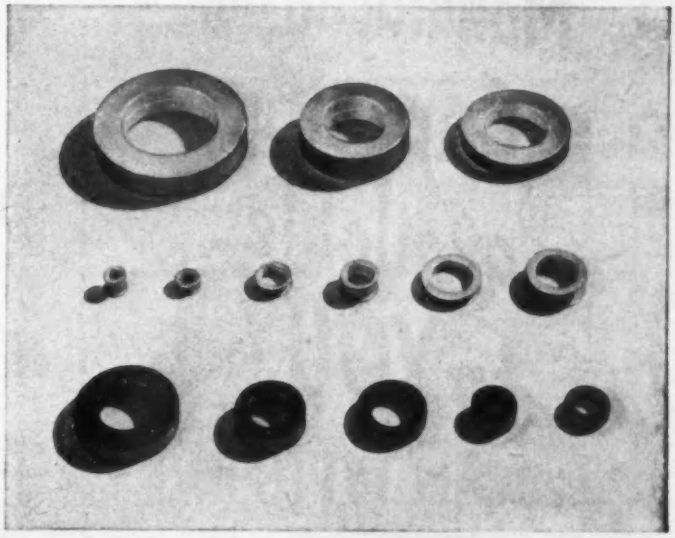

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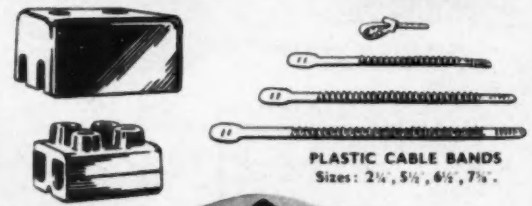

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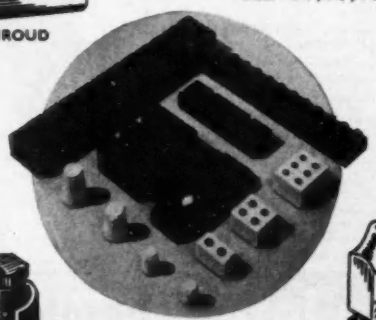

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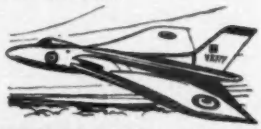

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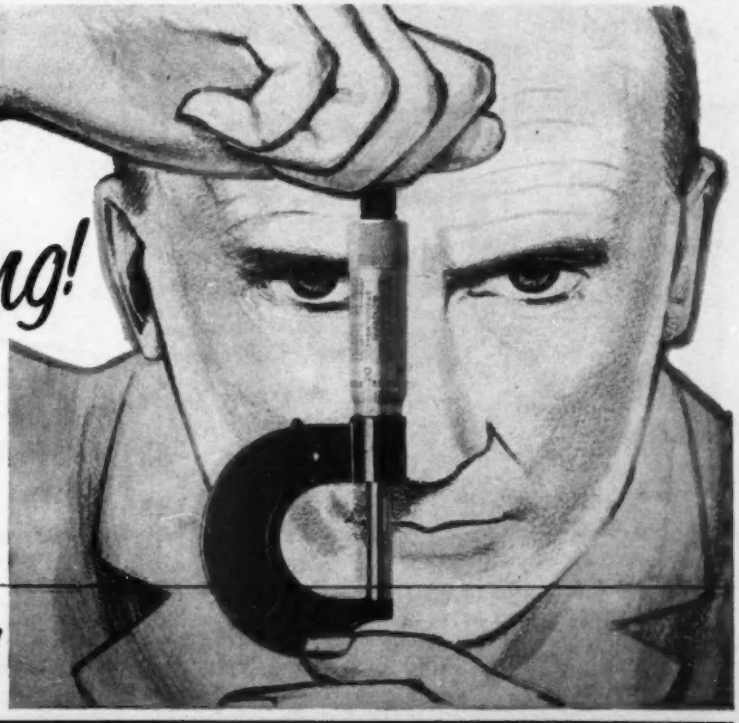

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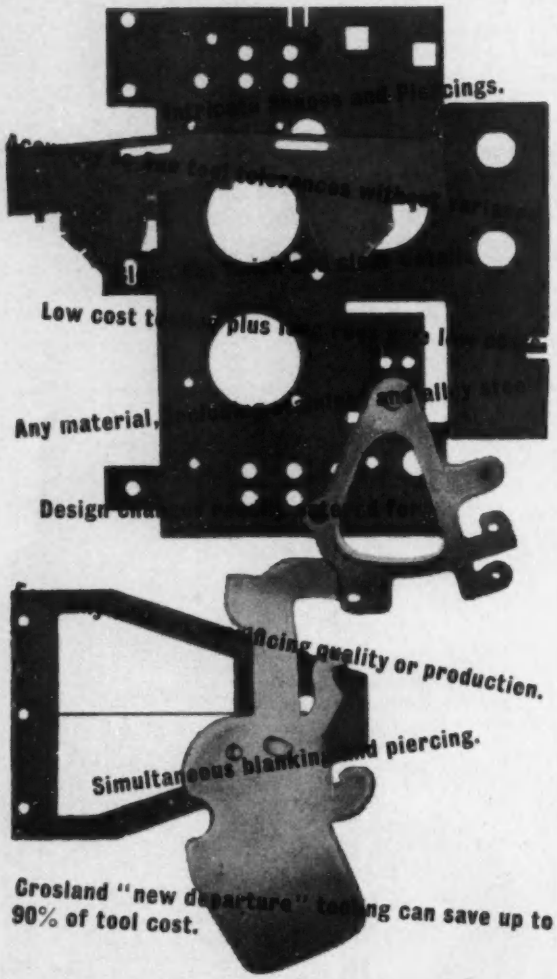

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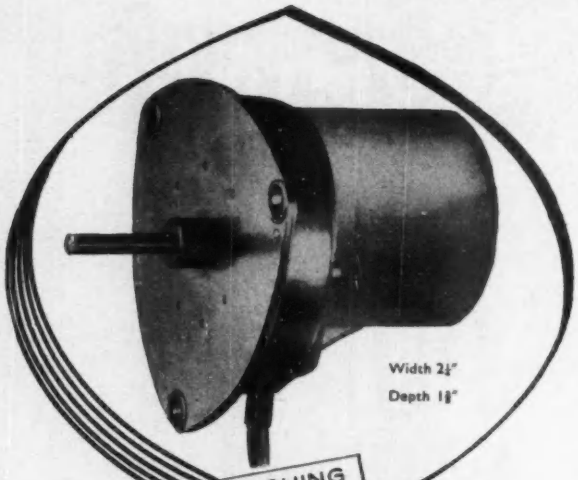

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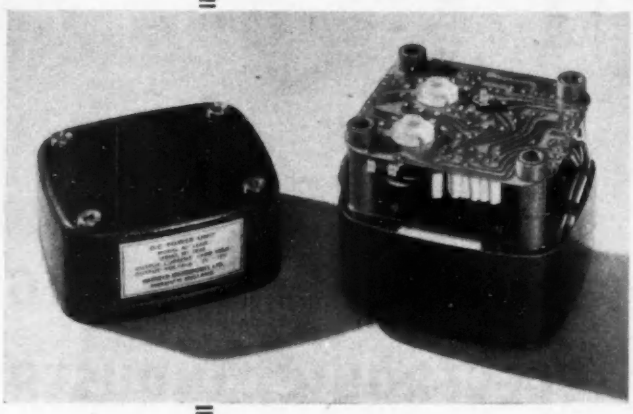

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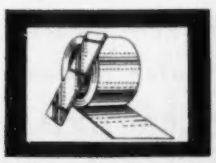

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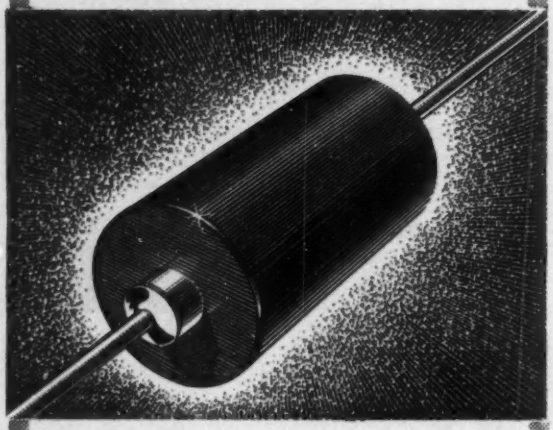

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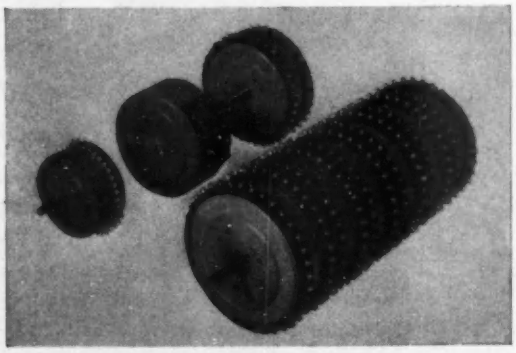

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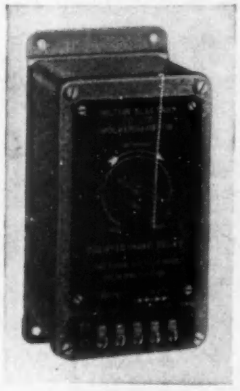

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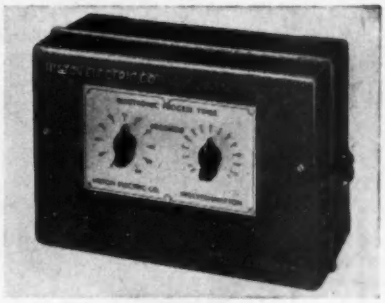

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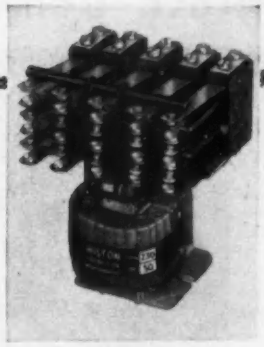

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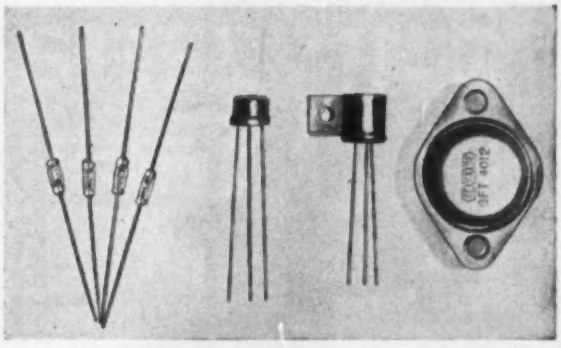

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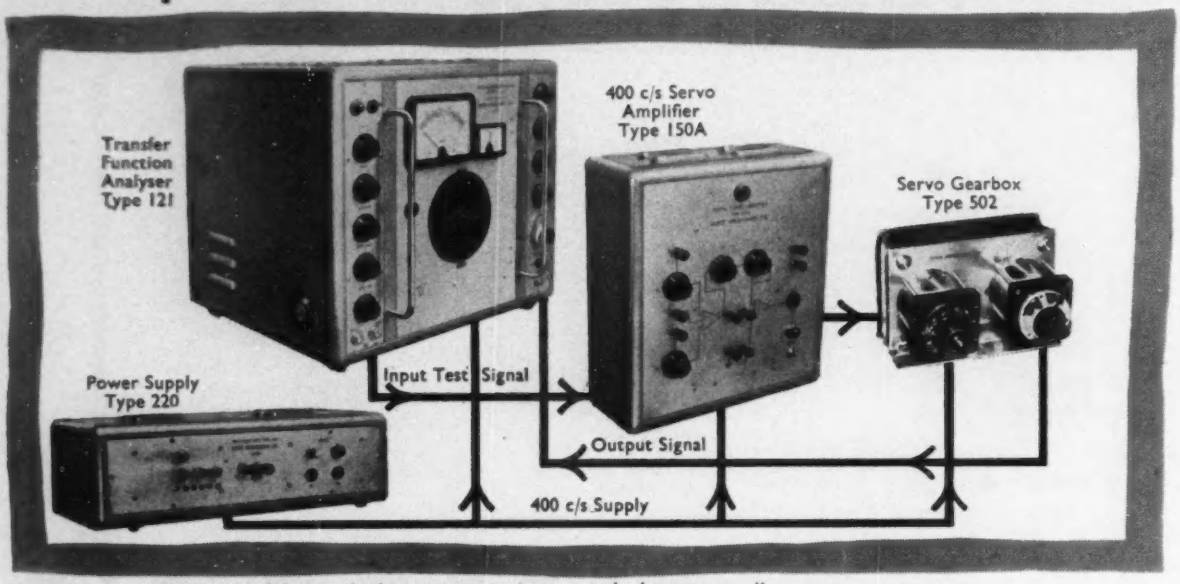

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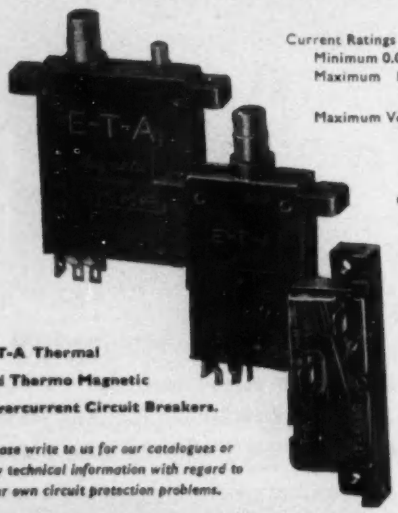

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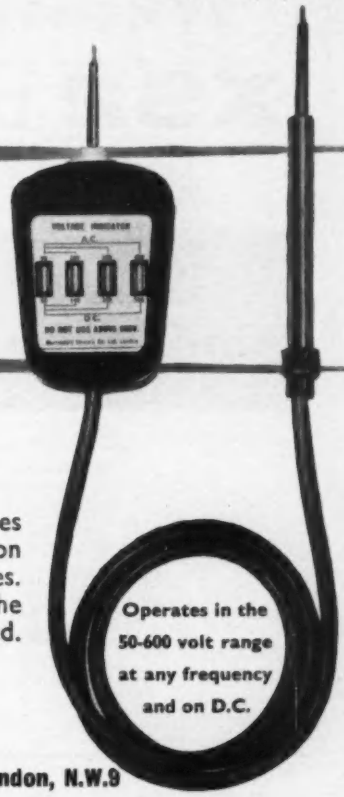

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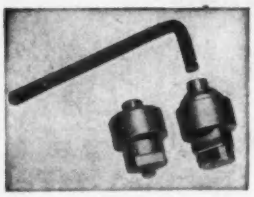

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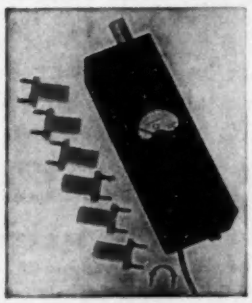

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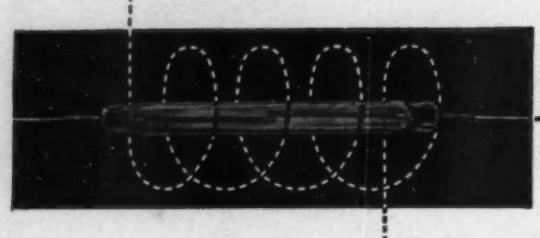

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OFFICIAL APPOINTMENTS

CAREERS FOR RADIO TECHNICIANS in Civil Aviation. Vacancies for Radio Technicians aged 19 or over at airports and radio stations throughout the United Kingdom, maintaining radio communication and electronic navigational aids. Fundamental knowledge of radio with some practical exp. required for entry. Training given on the equipment in use. *Salary* approx. £810 at age 25, rising to £930. 3½ weeks holiday with pay. Paid sick leave. Facilities to study for higher quals, giving good prospects of pensionable posts and promotion to Telecommunications Technical Officer grades with salary max. £988, £1,128 and £1,388. Apply for further details to Ministry of Aviation (Est./5a), Room 755, Adelphi, John Adam St., London, W.C.2, or any Employment Exchange, quoting Westminster O/N. 3552. W 5219

CENTRAL ELECTRICITY GENERATING BOARD, South Eastern Region, Regional Research and Development Department. Applications are invited for the following position in the above Department, located at Cockfosters, Herts. Assistant Engineer, Electrical Branch. The successful candidate will be responsible to the Measurements and Instrumentation Section Head and will carry out special field work, developing his own techniques in radio and television interference measurements with noise level measurement and noise suppression, harmonic and vibration analysis, mechanical stress and strain analysis and allied work. This post requires experience in electronics and measurement techniques. Salary, dependant on experience and qualifications, will be within the range of £1,155 to £1,780 per annum inclusive of London Allowance in accordance with Grades 6/7/8 of Schedule 'B' Class CX of the N.J.B. Agreement. Applications quoting S.E.25/61 and stating age, qualifications, experience, etc., should be addressed to the Regional Secretary, Ergon House, Horseferry Road, London, S.W.1, so as to arrive by not later than 15th July, 1961. W 5239

CROYDON. The County Borough of Croydon Education Committee invite applications from suitably qualified teachers for the following vacancy tenable from September next:— Croydon Technical College, Fairfield, Croydon, Principal: D. A. Green, M.B.E., B.Sc., M.Ed. Department of Electrical Engineering—Graduate Lecturer. Applications are invited for the post of Graduate Lecturer in Electrical Engineering. The successful candidate will need to be well qualified in Electronics and will be required to teach this subject at H.N.C. level. He will also be required to assist with the teaching of the City and Guilds Radio and Television Servicing course up to final standard. Salary in accordance with the Burnham Technical Scale is at present £1,370 rising to £1,550 per annum together with London Area Allowance of £38 or £51, and is under review. Further particulars and forms of application may be obtained from the Chief Education Officer, Education Offices, Katharine Street, Croydon, and should be returned to the Principal not later than first post on Friday, 14th July, 1961. W 5245

ELECTRONICS. Senior technician with experience in electronics and electrical equipment generally, wanted for work in new laboratories of the Department of Mechanical Engineering, Queen Mary College (University of London), Mile End Road, E.1. Placing on salary scale according to experience and qualifications. Scale £690-25-815 p.a. plus London Weighting up to £45 and in some cases plus £30 or £50 special qualification award. Five-day week. Four weeks annual leave. Pension scheme. Letters only to Registrar (M.S.T.), giving full details of age, experience, present work. W 5228

ELECTRONIC ENGINEER with knowledge of control systems required by Hydraulics Research Station, (D.S.I.R.), Wallingford, Berks., for design and development of control equipment for hydraulic models and research facilities. Post offers opportunities to work on interesting and novel control problems. Pass degree, H.N.C. or equiv. expected. Appointment either as Assistant Experimental Officer (interim salary range £625 (age 22), £776 (age 26)- £957 or Experimental Officer (interim range £1,057 to £1,296) depending on age and experience. Leave: A.E.O. 18 days p.a., E.O. 22 days p.a. Favourable housing prospects for married officers. Application forms and further information from the Director, Hydraulics Research Station, not later than 15 July, 1961, quoting reference 6E. W 5209

HEREFORDSHIRE COUNTY COUNCIL College of Technology, Letchworth. The Governors invite applications for a position as Lecturer in Electrical Engineering. Interest in Electronics and/or Automatic Control and advantage. Salary scale (under revision) at present £1,370 to £1,550. Applications in full detail should be sent immediately to The Principal, College of Technology, Broadway, Letchworth. W 5225

KENT EDUCATION COMMITTEE, Medway College of Technology. The Department of Electrical Engineering has vacancies for two Lecturers in Telecommunications or Electronics. Candidates should be University Graduates with industrial experience in a branch of electronics or telecommunications. Previous teaching experience is not necessary. The present salary is £1,350 to £1,550 but it is being reviewed. Application form and further particulars can be obtained from the Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham, Kent. s.a.e. W 5241

LEEDS REGIONAL HOSPITAL BOARD. Regional X-ray and Radiological Engineer. Applications are invited for the above appointment which is a new post to be established in the Regional Engineer's Section of the Board's Headquarters Staff. Applicants should be corporate members of the Institution of Electrical Engineers and membership of the Society of Radiographers or the Institution of X-ray Technicians is also desirable, but applications from candidates not possessing these qualifications, but with extensive experience in X-ray equipment may also be considered. The person appointed will be responsible to the Regional Engineer for all diagnostic X-ray installations in the Region and the preparation of the lay-outs for X-ray units including electrical specifications and drawings. He will also cooperate with the Hospital Physicists in providing appropriate protection from radiation. The salary will be in accordance with the Main Grade Engineer scale, £910 × £35(1) × £40(2) × £45(5) × £50(7) - £1,600, except that the minimum of the scale for a corporate member of the I.E.E. shall be deemed to be £1,160 per annum and a person not being a corporate member of the I.E.E. shall not proceed beyond £1,400 per annum. Applications, stating age, qualifications, present and previous appointments (with dates) together with the names and addresses of two referees to the Secretary, Park Parade, Harrogate by 14th July, 1961. W 5229

PETERBOROUGH JOINT EDUCATION BOARD, Peterborough Technical College. Applications are invited for the post of Assistant Lecturer Grade B in Electrical Engineering. Candidates should possess a degree or equivalent qualification in engineering and have had some industrial experience. Salary in accordance with the Burnham Technical Scales (which are now under review) with allowances for degree and approved industrial experience: £700 minimum rising to £1,150 per annum. Further particulars and forms of application obtainable from the Principal, Peterborough Technical College, Eastfield Road, Peterborough. W 5243

LONDON COUNTY COUNCIL, SOUTH EAST LONDON TECHNICAL COLLEGE, Lewisham Way, S.E.4. Department of Electrical Engineering. Applications are invited for several Lecturers and Assistant Lecturers (Grade B) in advanced Electrical Engineering, Instrumentation and Control Systems, to fill vacancies due to staff promotion. Candidates should be well qualified, have industrial experience and preferably some teaching experience. The Department offers Full-time, Sandwich, Part-time Day and Evening Courses. Successful candidates will be required to teach up to Part III I.E.E. Salary Scales: (i) Lecturers, £1,408 to £1,601 with possible entry above the minimum. (ii) Assistant Lecturers (Grade B), £738 to £1,486. Point for entry and maximum dependent on relevant industrial or teaching experience and qualifications. Application forms from the Secretary, returnable within two weeks, quoting (FE.3a/E/1554/7). W 5227

MIDDLESEX COUNTY COUNCIL, Education Committee, Willesden Technical College, Denzil Road, Willesden, N.W.10. Principal: L. L. Allen, B.Sc.(Eng.), A.K.C., M.I.Mech.E. M.I.E.E., M.I.Prod.E. Department of Electrical Engineering. Applications are invited for the following posts: 1 & 2 *Lecturers in Electrical Engineering*. Candidates should be graduates with good industrial or research experience and able to teach to post-Higher National Certificate standard one or more of the following subjects: Electrical Engineering, Power Technology, Radio Technology. Ability to teach Mathematics to Final Higher National Certificate standard would be an additional advantage. 3 & 4 *Assistant Lecturers (Grade B)*. Candidates should be graduates with good industrial or research experience and be able to teach Ordinary National Certificate and comparable City & Guilds subjects in Electrical Engineering. Willesden Technical College is a large college situated within a short distance from the centre of London. Engineers interested in an academic career will be given every opportunity and encouragement to continue their studies and to take an active part in research and development projects. Continuous contact with industry is encouraged. Salary: Lecturers, £1,408-£1,601 per annum. Assistant Grade B, £828-£1,486 per annum. Additions may be given for industrial experience (up to £330 above the minimum), training and study (up to £120 above the maximum). Further particulars and application forms (foolscap s.a.e.) from the Clerk of the Governing Body, 163 Willesden Lane, N.W.6, to be returned within two weeks. C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5223

MINISTRY OF AVIATION requires Engineer III at Air Technical Publications, Chessington, to assist in preparation of Service publications on digital data handling including computers. Duties include liaison with Service and design branches and research establishments. *Quals.*: Should have served recognised engineering apprenticeship or have had equiv. training, and be corporate members of the Institution of Mechanical, Electrical or Civil Engineers or have exempting quals. Sound knowledge of electronics with experience of digital data techniques is essential. Radar experience advantageous. *Salary*: £976-£1,480 (London). Starting salary at age 34 and over £1,308. Not established but opportunities to compete for establishment may arise. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.269/1A. Closing date, 14 July, 1961. W 5211

OFFICIAL APPOINTMENTS (Cont'd.)

MINISTRY OF AVIATION Electrical Inspection Directorate, Bromley, requires Technician for inspection and testing of electronic equipment during manufacture and installation at sites in the U.K. and abroad involving considerable travelling. Applicants should have considerable industrial exp.; comprehensive background of radar and electronics and practical knowledge of exp. in all the following fields: Centrimetric radar, U.H.F., line communications and digital and analogue data handling. Exp. of inspection work an advantage. *Quals.* Recognised eng. apprenticeship or equiv. training. ONC., appropriate C. & G. Final Certs. or equiv. *Salary*: £1,028 (on entry)-£1173. Good prospects for advancement and pension. Application forms from Manager (PE2092), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon St., London, E.C.4. W 5226

MINISTRY OF AVIATION requires Engineer III in Directorate of Electronics Production (Radar), London to assist in planning and progressing the production and installation of large ground radar projects and maintain liaison with the user, the contractor, and the design and inspection authorities. *Quals.*: Have served a recognised engineering apprenticeship, and either be corporate member of the Instit. of Mech. or Elect. Engineers, or have exempting quals. Sound knowledge of electronics and modern production techniques applicable to radar equipment required and experience of the installation of such equipment advantageous. *Salary*: £991-£1,490 (Inner London). Commencing salary at age 34 or over £1,318. Not established, but opportunities to compete for establishment may arise. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1. quoting D.264/1A. Closing date, 14 July 1961. W 5208

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. Assistant Lecturer. Applications are invited from scientists or engineers with an interest in basic or applied measurements and/or automatic control for the post of Assistant Lecturer in the Department of Production Technology and Control Engineering. The Department is engaged in teaching measurements and automatic control at Diploma of Technology and Post-graduate level. Applicants should have an honours degree or a Diploma in Technology. There are facilities for research and study for higher qualifications. Salary on Burnham Scale £930 rising to £1,390 depending on qualifications and experience. Forms and particulars from the Secretary. W 5237

TELEMETRY ENGINEER Large Oil Company requires a Telemetry Engineer for service in the Middle East. Applicants should be Associate Member of the Institute of Electrical Engineers and have eight to ten years experience in the Electronic Industry which should include the operation and maintenance of telemetring and remote control equipment, preferably as applied to normal communication circuits. Knowledge of transistor applications, printed circuit techniques and electromechanical devices is essential. It is desirable that applicants should also have experience of one or more branches of Communications, i.e. Carrier/repeater Systems, V.F. Telegraphs, Exchanges and Radio. Pensionable post with gross pay not less than £3,000 per annum. Annual Home Leave with paid passages. Air conditioned furnished accommodation provided for which rent is charged but owing to shortage of married accommodation, married applicants should be prepared for initial separation. Applicants aged 30-40 should write in detail, quoting No. 1022 to Box No. 4095 c/o Charles Barker & Sons Limited, Gateway House, London, E.C.4. W 5218

MINISTRY OF AVIATION requires an Engineer III at A.T.P. (Air Technical Publications), Malvern, Worcestershire, to prepare or supervise the preparation of Service technical publications on radars and associated equipment. Qualifications: Applicants should have served a recognised engineering apprenticeship and either be corporate members of the Institution of Electrical Engineers or have exempting qualifications. A background of practical experience in the radar and electronics field is essential. Previous experience of writing or editing technical publications would be an advantage. Salary: £911-£1,390 p.a. (Provincial). (National rates from 1.1.62). Starting salary at age 34 and over £1,218. Opportunities to compete for establishment may arise. Forms from the Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.320/1A. Closing date 19 July, 1961. W 5254

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (a) Experimental Officers and (b) Assistant Experimental Officers in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on 31/12/61, be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b). Qualifications should normally include H.S.C., or G.C.E., or equivalent, or H.N.C., a University degree, or a Diploma in Technology. Provisional admission if taking examinations in 1961. Inner London salary scale (a) £1,147-£1,396; (b) £503 (at 18) to £856 (26 or over) rising to £1,038. Promotion prospects. Further education facilities. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/94-95/61. W 5212

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as Assistants (Scientific). Ages at least 17 and normally under 27 on 31/12/61 with appropriate educational or technical qualifications (normally G.C.E. with passes at 'O' or 'A' level in four distinct subjects including English Language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least one year's experience in: (i) engineering or physical sciences, *or* (ii) chemistry, bio-chemistry or metallurgy, *or* (iii) biological sciences, *or* (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing. National salary from £354 (at 17) to £551 (at 25 or over) rising to £723. Promotion prospects. 5-day week generally. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/59/61. W 5210

THE TECHNICAL UNIVERSITY OF DENMARK, Copenhagen. Professor of Communication Theory. The Technical University of Denmark will during the next few years be expanded and moved from Copenhagen to a suburb 8 miles north of the city. Position as full professorship open for qualified scientist interested in developing teaching and research in Communication Theory. The teaching comprises an undergraduate course in communication theory and graduate courses in information and coding theory. Lectures in English acceptable. Write for further information: Chairman, Electrical Engineering Department, Technical University, 10 Oestervoldgade, Copenhagen-K, Denmark. W 5244

UNIVERSITY OF QUEENSLAND. Reader and Senior Lecturer in Electrical Engineering. The University invites applications for two posts in the Electronics and Communications Section of the Department of Electrical Engineering. **Reader**: Salary £A2960-60-£A3200. Applicants are required to have a higher degree in Electrical Engineering and experience in some aspect of electronics or communications. The successful applicant is required to take charge of the electronics and communications section of the Department of Electrical Engineering under the general direction of the Professor of Electrical Engineering. Evidence should be submitted of experience in lecturing on theoretical topics to honours students and of ability to supervise and participate in research projects. **Senior Lecturer**: Salary £A2520-70-£A2870. Applicants must hold an Honours degree in Electrical Engineering, with specialisation in electronics. The duties will include lectures on advanced topics in the field of electronics and arrangement of the appropriate practical work. Participation in the research work of the Department is expected. The University has recently planned a Computer Centre and a G E 225 computer is expected to be in operation within one year. The successful applicants will be entitled to participate in the benefits available to the academic staff which include F.S.S.U. type Superannuation, Housing Assistance, Study Leave and Travel Grants. Additional information on the conditions of appointment, staffing and activities of the Department, together with application forms will be supplied upon request to the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close on 31st July, 1961. W 5250

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, Sackville Street, Manchester, 1. A Technician and a Senior Technician are required in the Chemistry Department to work with a research team engaged on important chemical research, and specifically to devise, develop and operate electronic equipment playing a vital part in these researches. A recognised qualification in electronics would be desirable, but not essential. Applicants should have a good theoretical knowledge with either industrial experience or H.M. Forces training. Salary scales: Technician, £490 to £675 per annum. Senior Technician, £690 to £815 per annum. An addition to the above rates of £30 per annum (Technician) and £30-£50 per annum (Senior Technician) is payable for approved qualifications. 5-day week. Superannuation Scheme. Applications with full details quoting REF. No. C13, should be addressed to the Bursar at the above address to arrive not later than one week after appearance of advertisement. W5235

VACANCIES FOR ELECTRONIC TECHNICIANS occur at the *Medical Research Council's* Clinical Psychiatry Research Unit, Graylingwell Hospital, Chichester, Sussex, as follows: (1) Technician, £595 × 25—£720 p.a., to develop and be responsible for the operational efficiency of electronic apparatus. Ordinary National Certificate or G.C.E. at Advanced Level in Scientific Subjects or equivalent and five years' experience required. (2) Junior Technical Officer, £410—£860 p.a., to develop electronic apparatus and to assist with experimental work. Minimum qualifications G.C.E. with Advanced Level in two Science subjects. Both appointments will be supervised by a physicist, and attendance at classes may be granted. Applications with names of two referees to be sent to the Director. W 5242

SITUATIONS VACANT

AN OLD ESTABLISHED cable company contemplating diversifying has vacancy for Managers in the following depts: Electronics (parts and supplies), Hearing Aids (sales of finished items), Tape Recorders (Sales), Radio & T.V. (Transistors, parts and finished items to trade), Loud Hailers and P.A. (Sales). Will those with qualifications in the appropriate fields interested in setting up departments (all appointments are in Sales Depts.) please give full details of their experience, age present emoluments and sphere of activities to the Chairman, Box W 5213.

DEVON COAST AREA now offers employment in addition to all the well-known attractions of the West Country. Senior Electronic Engineers, with experience of transistor circuitry, are invited to apply for a post in a laboratory engaged in the design of a wide range of electronic instruments. Academic qualifications are desirable, but the most important qualification is the ability to achieve results. The successful candidate will have the opportunity of living in the heart of the most popular holiday area of the British Isles. Write in confidence to the General Manager, Hatfield Instruments Ltd., Burrington Way, Plymouth. W 2046

ELECTRICAL/ELECTRONIC ENGINEER. A major manufacturer of laboratory instruments and apparatus has a vacancy for a Section Leader in its Research and Development Division based on N.E. London. Inventiveness, backed by at least H.N.C. and varied small-scale industrial experience is desirable. Pension Scheme. 5-day week. Holiday arrangements honoured. Box W 5238.

CLASSIFIED ADVERTISEMENTS

continued on page 190

EE 35 237 *for further details*

THE EDISWAN 16P13 Water Cooled RF Power Valve

without a jacket!

The latest Ediswan water cooled valve has no jacket. Instead there is a spiral copper water tube attached directly to the anode. This method is much more efficient, keeps the valve cooler, and makes it cheaper to install and easier to maintain.

Tot up the extra advantages and then switch to these new valves for any application where you are at present using water jacketted valves.

1. No water jacket—simplifies installation.
2. Seals eliminated reducing leakage risk.
3. Low water requirements—1 litre/3 kW anode dissipation.
4. More compact than conventional water cooled valves of similar rating.
5. Includes the Ediswan patented over-dissipation protection device.

RATINGS:		15P12	16P13
Filament voltage (volts)	Vf	5·0	8·0
Filament current (amps)	If	32·5	26·0
Maximum anode voltage (kV)	$V_{a(max)}$	6·0	8·0
Maximum anode dissipation (kW)*	$P_{a(max)}$	0·6	3·0
Maximum operating frequency (full rating) (Mc/s)	$f_{(max)}$	1·5	1·5
Maximum RF power output (kW)	P_{out}	2·5	7·5

Write for a copy of our latest catalogue
EDISWAN INDUSTRIAL VALVES AND CATHODE RAY TUBES.

** Other valves with anode dissipations up to 6 kW will be available shortly.*

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Associated Electrical Industries Limited
Radio & Electronic Components Division,
155, Charing Cross Road, London W.C.2. Telephone GERrard 9797
16/22

SITUATIONS VACANT (Cont'd.)

ELECTRONIC DESIGN / DEVELOPMENT ENGINEERS required for expanding R. and D. Division of Electronics Group. Previous proved ability in the design of units for medium and small quantity production runs is desirable. Candidates must have transistor or U.H.F. experience and should be of Degree Standard or equiv. Mechanical Design experience would be an advantage. Proven ability to design will be accepted as a suitable qualification. Salary will be commensurate with the applicants qualifications and experience. Please apply in writing to the Chief Engineer, Beme Telecommunications Ltd., Hythe, Hants. W 5234

ELECTRONIC DEVELOPMENT ENGINEER required by rapidly expanding Electronics Division of Control Gear Manufacturers in Midlands, to work on the development of a wide range of Industrial Electronic devices. Preferred qualifications H.N.C. with experience of Electronic Development or Design. Permanent position, non-contributory Pension Scheme. Present staff advised. Box No. W 5233.

ELECTRONIC TECHNICIAN with good practical and theoretical knowledge of general electronics and a working knowledge of sheet metal and light engineering practise. Write giving full details, Grundy & Partners, Ltd., 3, The Causeway Teddington, Middx. W 5214

EXPERIMENTALIST required by the United Kingdom Atomic Energy Authority, Dounreay Experimental Reactor Establishment, Thurso, Caithness, Scotland, to work in the Control Engineering Development Group. The successful applicant will assist in the design, development and application of control and instrumentation equipment for the Groups' Control and instrumentation programme. The current work in this field is on problems connected with both the Fast Reactor and the Material Testing Reactor. On the systems aspects we are investigating simulation techniques, data handling and presentation and reactor rig control schemes. The technique side of the work currently includes burst slug detection, in-pile measurement of physical properties of materials and development of equipment for direct transfer function and autocorrelation. A pass degree in Maths and Physics or Electrical Engineering, or H.N.C. in an appropriate subject is normally expected. All applicants should have had experience in the industrial control and instrumentation field. Salary on the scale £1,165 to £1,430 according to qualifications and experience. Rented housing and house purchase assistance available for married officers living beyond daily travelling distance. Single accommodation available. Contributory superannuation. Send postcard for application form to Personnel Manager at above address quoting Ref. 265/42. W 5251

INSTRUMENTATION ENGINEERS required for work on transonic and supersonic wind tunnel equipment. Applicants should be between 21 and 35, preferably with a degree or H.N.C. Experience in relay circuits, servo-systems or electronic circuits would be an advantage. A chance to work in Research conditions at industrial salary scales. Assistance with housing and removal expenses. Applications in writing to Chief Executive, Aircraft Research Association, Ltd., Manton Lane, Bedford. W 2042

L L L new roof—new jobs—new horizons. Senior Laboratory Engineers, Sales Engineers for inside and outside duties in Electronic Instrumentation. The new Livingston Laboratories' roof houses some of the most modern facilities in the country and offers exciting prospects for really first-class men who want a career where full scope is given to initiative. Please write or phone, in confidence of course, to Mr. David Rennie, Managing Director, Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1. Telephone: GULliver 8501. W 5249

LOUIS NEWMARK LIMITED, leading company in the design of auto pilots for helicopters are expanding their facilities at their Development Laboratories at Croydon and have the following vacancies to be filled immediately. Engineers and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate with experience. Pension Scheme. Apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark Ltd., Prefect Works, Stafford Road, Croydon, Surrey. W 351

OVERSEAS. Electronic Technicians are required by an Oil Exploration Company with Headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle, and swamp. The equivalent of an H.N.C., with practical experience in electronics, is essential. Tours overseas are of up to two years followed by home leave. Write with full particulars, covering any time spent in the Forces, to Box No. W 356.

PERA REQUIRES an additional electronic engineer for the design and development of special circuits and prototype instruments. Experience in transistor circuit design would be an advantage. The position will involve working in collaboration with member firms and developing basic ideas for instruments to the production stage. Applicants should have a minimum of H.N.C. or equivalent. F.S.S.U. pension scheme. Write stating age, qualifications and salary required to the Secretary, (R.869), Production Engineering Research Association, Melton Mowbray, Leics. W 5217

PHYSICS OR ELECTRONICS GRADUATE. A graduate in Physics and/or Electronics, with industrial experience. Age 25 to 35. To pursue photo-cell development in combination with optical and electronic devices, for gauging and machine tool control. Salary according to ability but not less than £1,000. W 5220

RANK PRECISION INDUSTRIES LIMITED Central Research Laboratories, are seeking a Senior Electrical Engineer. We require an engineer to undertake the design of control and associated circuits in xerographic office machinery. Applicants, who should possess H.N.C. or equivalent qualifications, should have experience in the design of relay circuits, simple transducers and control devices and be able to specify motors and other light electrical components. The engineer will also be required to supervise design on the drawing board. Our laboratories are welll established and cover a wide range of activities. A pension scheme is in operation and there are canteen facilities. Please apply, giving full details of education and experience to: The Laboratory Manager, Rank Precision Industries, Ltd., Central Research Laboratories, Sulgrave Road, Hammersmith, London, W.6. W 5231

SALES ENGINEER required whose primary duty will be to locate on a country-wide basis and negotiate large-scale orders for sub-manufacturing and assemlby work in the electronics engineering industry. The successful applicant will have a good knowledge of this industry and wide sales experience. He will be within the age range 30/40 and will preferably be a car owner. Salary, commission and expenses will be by arrangement. Applications in the first instance of Managing Director, Box No. W 2045.

TEST ENGINEERS WITH AMBITION are invited to apply for an interesting post involving the test and calibration of a wide range of electronic equipment. Previous experience is essential and technical qualifications would be an advantage. Write in confidence to the General Manager, Hatfield Instruments Ltd., Burrington Way, Plymouth. Tele. 72773. W 2047

SENIOR AND JUNIOR ENGINEERS. The British Manufacture and Research Company Limited is expanding rapidly in the field of industrial products as well as continuing its armament programme. This expansion providing excellent opportunities for advancement calls for further electronic and electrical engineers with the following qualifications and experience: Senior Engineers; Degree or equivalent in Electrical Engineering or Physics and some years experience in industry, preferably in the field of electro-mechanical control equipment. Junior Engineers: O.N.C. (Electrical) preferred, with some laboratory and/or drawing office experience. The Company, a member of the Hispano Suiza Group, offers above average salaries plus payment for overtime. Canteen, sports facilities, pension scheme and sick fund are available. Applications, stating qualifications, experience and present salary should be addressed to the Chief Engineer, British Manufacture and Research Company Limited, Grantham, Lincs., quoting ref. SJ/EE. W5236

SENIOR TECHNICIAN age 21-30, required to work in new medical engineering laboratories on development, construction and maintenance of electronic and other equipment for medical research. Salary in range £615-£915 per annum, according to experience and qualifications. Application form from: Secretary, Postgraduate Medical School, Ducane Road, W.12. W 5221

TECHNICAL DIRECTOR required by the Acoustical Investigation & Research Organisation Ltd. AIRO). AIRO performs consulting and field work and laboratory measurements in Acoustics, particularly in the fields of Architectural Acoustics and Noise Control. The firm operates a modern acoustic laboratory at Hemel Hempstead, Herts., containing Anechoic and Reverberation Chambers; and is backed by a large, progressive group of engineering companies. For this position a qualified scientist is required with experience in acoustics. An attractive salary is offered, with membership of a superannuation scheme. Please send résumé to AIRO Ltd., 118 Cromwell Road, London, S.W.7, FREmantle 5101. W 5246

SISUATIONS VACANT (Cont'd)

WORKS MANAGER required for a Company manufacturing industrial electronic control equipment. In addition to proved works management ability, candidates must have a strong electronic/mechanical engineering background with considerable experience in batch production. He will be directly responsible to the Managing Director and he will control mechanical and electronic production, the stores and purchasing office. The position offers considerable prospects for advancement to an experienced electronic engineer with a flair for organising and controlling all aspects of production. Pension scheme. Location S.W. London. Please send full details in confidence to Box W 5253.

YOUNG ELECTRONIC ENGINEER REQUIRED with knowledge of transistor circuits. Attractive salary, progressive position, contributory pension scheme. Box No. W 5215.

CAPACITY AVAILABLE

SUB-CONTRACT electronic wiring and assembling wanted. Prototype, small batch or regular production runs. Bowers Electromation Engineering Ltd., 209a Hertford Road, Edmonton, London, N.9. HOWard 2231. W 2033

GREATER STAMPING CAPACITY— At lower cost. Our new 20 ton Swiss Automatic Punch Presses produce up to 84,000 finest precision stampings per hour. Capacity is also available for: Cold rolled and cold drawn Metal Sections, in self-colour or decorative finishes (strip width up to 4 in., strip thickness up to 19 SWG). Precision Strip-Slitting from 6 in. and 22 SWG down to any size required. Electrolytic Polishing of brass, nickel-silver, gilding metal and copper. Phone our Sales Manager, Burgess Hill 86505 and 2521. Hettich (GB) Ltd., Victoria Road, Burgess Hill, Sussex. W 5222

BUSINESS OPPORTUNITIES

ADVERTISER REQUIRES to purchase a share holding in small electronics manufacturing company wishing to widen the scope of its activities. Administrative and technical support available for an efficient production unit. Established product outlet available. Home Counties location preferred. Box No. W 2038.

MANUFACTURERS OF PLASTIC MOULDINGS, mainly Compression, in process of expansion programme, wish to make contact with selling agents able to introduce orders on a commission basis. Box No. W 2037.

SERVICE

ELECTRONIC DESIGN, development, prototype manufacture. Sub-contract work undertaken. London area. Box W 2041.

EXTRA PRODUCTION FACILITIES: Skilled workers + floor space + expert supervision = extra production facilities for you. See page 170. W 355

METALWORK. All types cabinets, chassis, racks, etc., to your own specifications. Philpott's Metalworks Ltd., Chapman Street, Loughborough. W 341

TRANSFORMERS DESIGNED AND MANUFACTURED Prototypes or batch productions of all types up to 3 KVA. Prompt delivery. Suppliers to BBC, ITA, Universities and leading Industrial Concerns. Est. 1922. Phone: SHI : 2483. Forrest Transformers Ltd., Shirley, Solihull, Warwickshire. Telephone SHIrley 2483. W 350

EDUCATIONAL

BATTERSEA COLLEGE OF TECHNOLOGY London, S.W.11. (ii) Microwave Physics. A postgraduate course in Microwave Physics leading to the M.Sc. or the Postgraduate Diploma of the College, will be held during the session 1961/62 beginning 2nd October, 1961. The course may be taken on either a full-time or a part-time basis. The full-time course has been accepted by the Department o Scientific and Industrial Research as suitable for tenure of its Advanced Course Studentships. Full details and enrolment forms from the Secretary, (Microwave Courses). W 5224

BRISTOL COLLEGE OF SCIENCE AND TECHNOLOGY Post graduate Short Courses, 1961-1962, 2 October-22 December, 1961. Radiological Health and Safety. A full time postgraduate course for those who are to be responsible for the operation of health protection services or who are to be engaged in research on the operational aspects of such a service. Fee £25, exclusive of meals and accommodation. Further details will be sent on request. Other courses. The programme of other postgraduate weekly and weekend courses in Aeronautical, Electrical and Mechanical Engineering, Biology, Chemistry, Mathematics, Pharmacy and Physics will be forwarded on application to- The Organizer of Short Courses, Bristol College o Science and Technology, Ashley Down, Bristol, 7. W 5232

CITY AND GUILDS (Electrical, etc.) on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of modern courses in all branches of Electrical Engineering, Applied Electronics, Automation, etc., send for our 148-page handbook —FREE and post free. B.I.E.T. (Dept. 337c), 29 Wright's Lane, London, W.8. W 316

COUNTY BOROUGH OF BOLTON, Education Department, Bolton Technical College. Principal: A. J. Jenkinson, M.A. Electrical Engineering Department, Head of Department, A. C. Normington, B.Sc.(Eng.), M.I.E.E., M.Brit.I.R.E. Diploma in Electronic Engineering. A three year full-time course for the College Diploma. Entry requirements: Four G.C.E. passes, including English language, Mathematics and Physics at "O" or "A" levels. Diplomates are exempted from: The entire Examination of the British Institution of Radio Engineers. Parts I and II of the Examination of the Institution of Electrical Engineers. Further particulars from the Principal, Bolton Technical College, Manchester Road, Bolton. W 5216

LEARN RADIO AND ELECTRONICS the New Practical Way! Very latest system of experimenting with and building radio apparatus—'as you learn'. Free Brochure from Dept. EE10, Radiostructor, Reading, Berks. W 353

TV. AND RADIO—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Certificate, etc., on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of Examination and Home Training Courses (including practical apparatus) in all branches of Radio, T.V. and Electronics, write for 148-page handbook—Free. B.I.E.T. (Dept. 337H), 29 Wright's Lane, London, W.8. W 187

LONDON COUNTY COUNCIL, South East London Technical College, Lewisham Way, S.E.4, Department of Electrical Engineering and Applied Physics. Senior Lecturer in Electrical Engineering required for the Full-Time Sandwich and I.E.E. Part III Courses. Candidates should be well qualified, have had good industrial experience and some teaching experience. Salary within the scale £1,586 × £50—£1,801 according to age and previous experience. Application forms from the Secretary, returnable within two weeks, quoting (FE.3a/E/1506/7). W 5240

MIDDLESEX COUNTY COUNCIL Education Committee, Hendon Technical College, The Burroughs, Hendon, N.W.4. Telephone: HENdon 6061. Principal Dr. E. Williams, B.Sc., F.R.I.C., Department of Electrical Engineering, Session 1961-1962, commencing 25th September, 1961. Sandwich Courses: 3-Year Course for Higher National Diploma in Electrical Engineering giving exemption from Parts I and II of the Institution of Electrical Engineers examinations and providing comprehensive studies for both Power and Electronics students, with an optional fourth year for the Part III examination of the Institution of Electrical Engineers. For this course students may be "works-based" or "college-based". "College-based" students are eligible to apply for local authority awards and grants: and the College assists students to obtain suitable industrial experience during the non-college period each year. Immediate application for admission to the above course should be made to the Principal at the college, from whom further particulars are obtainable. W 5248

FOR SALE

COPIES E.E. nearly complete 1952 to July '58. Offers. Send for details. Westwood, 46 George Street, Oxford. W 2044

LEADING DESIGNERS specify "Flexigarde" the flexible plastic coil for conduits, etc., also "Clerefranz" the Self Adhesive clear film for protection. Samples, etc. Crossley, Eastgate Street, Rochdale. Tel. 47272. W 5155

SURPLUS TO OUR REQUIREMENTS new un-used Fans. 142—Aerofoil Fans, Type 8.1QE, 8½ in. short casing. 220/250V. 1,350 r.p.m. 50 cycles, single phase. 348—Aerofoil Fans, Type 6.1PD, 6 in. short casing. 115/230V. 2,500 r.p.m. 50 cycles, single phase. Manufactured by Woods of Colchester, from whom repeats can be obtained. For further details apply: J. F. Crosfield Ltd., 2, Elthorne Road, London, N.19. Tel.: Archway 7531. W 5230

50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 2382). W 357

WANTED

BALL AND ROLLER BEARINGS, ETC. Wanted. Also surplus goods—especially hand tools —of all descriptions. For sale: metal ammo boxes in varying sizes, ideal for storage, despatch, etc. R. Pordes, 138 New Cavendish Street, London, W.1. MUSeum 5250. W 5180

ELECTRICAL RESEARCH ASSOCIATION

Physicist or Engineer

A vacancy exists for someone with special interest in electronic components to take charge of work covering these items:

- Automatic climatic testing of large numbers of resistors
- Long-term reliability of components stored at sub-zero temperatures
- Investigation of failure mechanisms in new types of resistor
- Collection and analysis of reliability data on components.

Personality and high ability to organize are essential and more important than purely academic qualifications, which may be H.N.C. or higher, either in electrical engineering or physics.

Salary will lie between £850 and £1,150 depending on experience and qualifications. Opportunities will exist to expand the work, to publish papers, and later to take part in more fundamental investigations.

There are several other vacancies for graduate physicists, concerned with problems on electrical materials, some extending into higher salary ranges.

Applications and enquiries should be addressed to the Personnel Officer, E.R.A. Laboratory, Cleeve Road, Leatherhead, Surrey.

Electronics

The Metal Box Company Limited requires graduates (or equivalent) with 2-5 years' experience in the electronics industry to be

PROJECT ENGINEERS

in its Electronics Section at Alperton (West London). Initially they would work on circuit design utilising electronics techniques in industrial processes.

These are opportunities to contribute initiative and originality in a field of great importance to the Company's growth and efficiency.

There are prospects of rapid advancement.

Apply to Head of Staff Division,

THE METAL BOX COMPANY LIMITED,
37 Baker Street, London, W.1.

quoting reference MSE/2.

COMMONWEALTH OF AUSTRALIA

WEAPONS RESEARCH ESTABLISHMENT, WOOMERA

RADIO DOPPLER TRACKING SYSTEMS

The Department of Supply invite applications for the following vacancy at the Weapons Research Establishment, WOOMERA, South Australia:-

POSITION; HIGHER EXPERIMENTAL OFFICER.

SALARY; £1,730/1,950 (Australian currency).

DUTIES; Supervise a section engaged on operation and maintenance of a radio doppler system and associated ground equipment. Develop improved methods of using radio doppler systems for trajectory measurements.

QUALIFICATIONS; A degree in engineering or physics, or equivalent qualifications, together with some experience in the relevant field, desirable.

CONDITIONS; At Woomera an allowance of £120 per annum is payable to a married man maintaining a family; others £70 per annum. Married accommodation will be made available within a reasonable period.

TRAVEL; Under certain conditions, first-class air/sea transport for the candidate and dependants (wife and dependent children) will be provided by the Commonwealth.

CONTRACT EMPLOYMENT; Consideration may be given to entering into an agreement for a three (3) or five (5) year contract of employment in Australia. In this case the Commonwealth will bear the cost of return fares; together with the cost of removing the successful applicant's furniture and effects up to a maximum cost of £500 (Australian), £250 each way.

APPLICATIONS; Forms obtainable from the Senior Representative, (AV107/2), Department of Supply, Australia House, Strand, London, W.C.2., with whom completed applications should be lodged as soon as possible.

Ferranti computers

announce vacancies in the

BRACKNELL LABORATORIES

for

SENIOR AND JUNIOR ELECTRONIC ENGINEERS

for the commissioning, installation and trials of special purpose digital data processing systems.

Applicants should preferably have Higher National Certificate or equivalent. The senior posts call for several years experience with electronic equipment, preferably including some time spent on digital circuits. Training will be given if necessary in the special techniques involved.

The appointments offer ideal working conditions in modern well-equipped laboratories, with opportunities to travel.

Interviews can be arranged in either London or Bracknell and applicants are invited to state their preference when writing for application forms to **T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs. Reference PFD/8 should be quoted.**

SOUTHAMPTON TECHNICAL COLLEGE

Principal: F. T. West, M.B.E., A.I.Struct.E., M.I.Prod.E.

Department of Electrical Engineering

Head of Department: K. E. Everett, M.Sc.(Eng.), B.Sc.(Hons), A.C.G.I., A.M.I.E.E., M.Brit.I.R.E.

Places are now being allocatd in the following Full-Time Courses in the Department of Electrical Engineering from September 1961:

Communication Engineering and Electronics: Three-year Course leading to College Diploma which exempts from Graduateship Examination of British Institution of Radio Engineers. Minimum age 16 years.

Marine Radio and Radar: Two-year course leading to the Postmaster General's First Class Certificate for Radio Officers and the Ministry of Transport Certificate in Radar Maintenance. Holders of these qualifications become qualified Radio and Radar Officers in the Mercantile Marine. Minimum age 16 years.

Further details and forms of application may be obtained from the Registrar, Southampton Technical College, St. Mary Street, Southampton.

FILTER DESIGN Engineers

Opportunities exist for both Senior and Junior Filter Design Engineers in our extremely well-equipped laboratories which are located at Ilford, Essex. The work is extremely varied and will provide wide scope for imagination and initiative in the design and development of networks incorporating ferrites, crystals and piezo-electric ceramic materials.

Applications are invited from engineers who are enthusiastically interested in filter design and in the exploitation of modern materials.

Applications in the first instance, stating qualifications, experience, age, etc., should be made to the Personnel Manager.

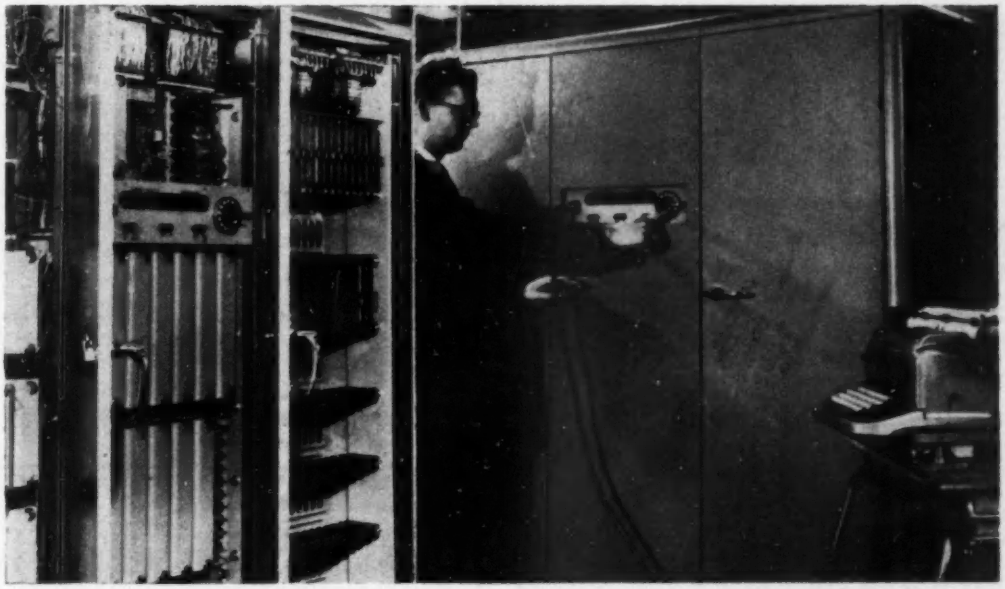
The Plessey Company Limited,
Vicarage Lane, Ilford, Essex.

Plessey

HAWKER SIDDELEY AVIATION

ACORN

Automatic Checking Equipment



THE PROBLEM

Large and complex equipments such as modern aircraft, weapons and vehicles contain advanced systems of radar, navigation, automatic landing, hydraulics, control, etc. Keeping these systems reliable and instantly ready at low cost demands automatic checking equipment of advanced design which avoids the expense of many men using much manual checking equipment.

THE SOLUTION

ACORN (Automatic Check-out and Recording Network) is being developed by a growing team of **DE HAVILLAND** engineers at Hatfield to provide a versatile equipment for use with all such complex systems.

THE REQUIREMENT

Senior and junior electronic engineers, designers and draughtsmen who are either expert or interested in the problems of computer programming, logical circuit design, automatic measurement, solid state switching, servo measurement and allied subjects are sought to join the team to help create a range of self-contained equipments.
In addition, there is a need for project engineers able to formulate with customers the problems which arise in these equipments.

THE OPPORTUNITY

This is a new field of engineering and the opportunity is open to capable and enthusiastic men to join a growing team tackling many challenging problems and developing new techniques. If you would like to take advantage of this opportunity please write to:

The Personnel Manager (Ref. 391)
The de Havilland Aircraft Company Limited
Manor Road, Hatfield

THE DE HAVILLAND AIRCRAFT COMPANY LIMITED

TAPE RECORDING EQUIPMENT TEST ENGINEER

required by

DATA RECORDING INSTRUMENT COMPANY LIMITED

Applicants must be fully conversant with setting-up, testing and trouble-shooting of multi-channel instrumentation type tape recording equipment.

A substantial starting salary is envisaged, which will be commensurate with knowledge and experience.

This position will present both a challenge and a first class opportunity to the right man, whose application, which will be treated in strict confidence, should be addressed to:

R. D. SIMPSON
Data Recording Instrument Co. Ltd.,
Woodthorpe Road, Ashford, Middlesex.

AUTOMATIC TELEPHONE & ELECTRIC COMPANY LTD.

Electronic Data Handling

The Company is engaged upon the development of large data handling systems involving a variety of techniques, from computing to data presentation. Progressive vacancies occur in the following categories:

System Engineers

Education in light current electrical engineering to degree standard or equivalent is preferred. Experience in data handling techniques and/or logical design, and the ability to interpret and assess customers' facility requirements in terms of system capability are of primary importance. The work requires a considerable amount of customer liaison and close co-operation with circuit design engineers.

Programmers

Electrical Engineers or mathematicians qualified to degree standard or equivalent. Experience in programming digital machines and an interest in "logical decision" programming, rather than pure calculation, is desirable. Close co-operation with system designers and the ability to achieve a grasp of the system function and principles are a necessary part of the work.

If you are interested in this class of work please write to;

The Personnel Manager
AUTOMATIC TELEPHONE
& ELECTRIC COMPANY LTD.
Strowger Works, Edge Lane, Liverpool 7

giving details of age, qualifications and experience, and quoting ref. EDH.

Posts are on the Company's established staff with superannuation scheme and full welfare facilities. Assistance with housing will be given in approved cases.

A GOOD OPENING IN

electronics

there is a vacancy for a

TECHNICAL ASSISTANT (ELECTRONICS)

in the new experimental laboratory of

MIRRLEES/NATIONAL RESEARCH DIVISION

HAZEL GROVE STOCKPORT - CHESHIRE

This is an interesting opportunity offering varied work in the maintenance and development of electronic testing equipment. The ability to construct circuits and instrumentation is essential and preference will be given to applicants with experience in a similar post.

Working conditions are congenial in a new laboratory, well-equipped and pleasantly situated.

Men with appropriate experience are invited to apply, in writing, giving full details, to the Personnel Officer at the above address.

ELLIOTT

COMPUTING DIVISION

Continued and rapid expansion provides opportunities for:

COMMISSIONING & TEST ENGINEERS

Preferably of H.N.C. level to work on the very latest types of transistorised Computers and associated peripheral equipment.

If you are a Junior Engineer with at least O.N.C. and you enjoy a challenge and are keen to learn, there are also opportunities for you.

METHODS ENGINEERS

with at least three years' experience of Electro Mechanical engineering using the latest techniques in semi conductors and printed circuits. Must be able to influence Design Engineers in the early stages of development, to ensure economic manufacture. Experience in work study techniques would be an advantage.

Evening and Saturday interviews can be arranged.

Apply Personnel Department (Ref. 381),

ELLIOTT BROTHERS (LONDON) LIMITED
Elstree Way, Borehamwood, Herts.

Opportunities

IN SEMI-CONDUCTORS

In connection with our expansion and new development we wish to appoint immediately

2 SEMI-CONDUCTOR DEVICE DEVELOPMENT ENGINEERS

2 SEMI-CONDUCTOR TECHNICAL PROCESS ENGINEERS

These appointments will be concerned with the development and manufacture of Silicon Rectifiers and associated Semi-conductor products and will appeal to Engineers with a basic training in Physics and Chemistry to H.N.C. or Graduate level, or experience in electronic component development. This is a good opportunity for men who wish to gain additional experience in Semi-conductor techniques in a modern plant in pleasant country within easy reach of London, and affords opportunity for contacts with the extensive Research Institutions of the Company and in particular with our Licensors in the United States.

Good salaries will be paid in line with experience and ability and immediate entry into the Superannuation and Life Assurance Scheme will be arranged.

Plessey

Apply in confidence to the Regional Personnel Manager,
Towcester Components Division, The Plessey Company Limited, Towcester.

LONDON
CROSFIELD
ENGLAND

ELECTRONIC ENGINEERS

of senior and junior status are required for interesting work within small teams on projects associated with the printing industry.

Originality and technical ability needed.

Senior engineers should be able to work on their own initiative. Experience in the use of semi-conductors advantageous, but not essential.

Degree or H.N.C. standard is the minimum qualification for senior positions.

Good salaries will be paid to engineers of ability and drive. Holiday arrangements will be honoured.

Apply in confidence to:—
Chief Engineer, Graphic Equipments Division,
J. F. CROSFIELD LTD.,
3, Hercules Street, London, N.7

MARCONI INSTRUMENTS LIMITED
St. Albans
Herts

If you are a qualified engineer, holding a degree or equivalent qualification and are interested in electronic measurement, now is your opportunity to join Britain's leading Instrument Company.

Current posts that would be of interest to ELECTRONIC OR ELECTRICAL ENGINEERS OR PHYSICISTS are :—

(a) PROJECT LEADER

To take responsibility for projects from basic design concept to final production o electronic instruments. This post calls for initiative and responsibility in development work. Candidates should possess previous experience of this type of work in the radio communication instrumentation field.

(b) CIRCUIT DESIGNER

With the ability to produce a complete circuit of an instrument proved by a working model from basic principles. Applicants must possess a thorough background of electronic measuring techniques.

Both posts carry attractive salaries, commensurate with qualifications and experience, and offer good opportunities for advancement in an expanding organisation, which is located on the outskirts of St. Albans in semi-rural surroundings, but within easy reach of London.

Apply: COMPANY PERSONNEL & EDUCATION OFFICER, **MARCONI INSTRUMENTS LIMITED**
c/o G.P.S. Dept., The English Electric Co. Ltd., English Electric House, Strand, London, W.C.2
Please quote reference number **EE 2970C**

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP

INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television, and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable instrumentation background. Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion. prospects are good.

Applications to:—

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

Ferranti electronics

invite applications from

ELECTRONIC ENGINEERS & PHYSICISTS

for development work on diverse problems of a fundamental nature including

(1) **THIN MAGNETIC FILM STORES FOR COMPUTERS**

(2) **FIBRE OPTICS**

(3) **TRANSPARENT PHOSPHOR & VAPOUR PHASE STUDIES**

(4) **SPECIALISED CATHODE-RAY TUBES**

Applicants should possess a degree or H.N.C. in Electrical Engineering or Physics, and for the first-named topic should have had experience of research and development in this field. The vacancies clearly offer the opportunity of varied experience in interesting branches of Applied Physics and carry attractive salaries which are subject to annual review.

Application forms can be obtained from T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs.

Please quote reference GCT.

technical sales executive

This is a new post in one of the Groups of a large Company engaged in the manufacture of electrical and electronic components.

The Technical Sales Executive will be responsible to the Group General Manager and will advise him on all matters relating to product policy, forward development, licensing and patents. He will be responsible for technical liaison at top level with leading customers and Government establishments, and in the course of his duties will be expected to travel overseas.

Candidates should be between 35 and 45 and possess a 1st or 2nd Class Honours Degree in Physics or Electrical Engineering. Considerable experience in the electronics industry is desirable; the ideal person will have held a senior engineering position in an electronic equipment or component manufacturing company, be earning a salary in excess of £2,000 p.a. and will have top senior level commercial experience.

Normal pension and life insurance schemes apply and the salary will be negotiated. Prospects for the successful candidate are extremely good.

Please reply to Box No. W 5252 *quoting reference* 190.

A CAREER IN AUTOMATION

Imperial Chemical Industries Limited
Wilton Works

has vacancies for

INSTRUMENT ARTIFICERS

for the installation and maintenance of all types of process instruments in a large new chemical works operating at Wilton in the North Riding of Yorkshire.

This is a comparatively new trade which is expanding rapidly; short training courses are available for tradesmen selected for this work.

Applications are invited from apprentice trained

INSTRUMENT ARTIFICERS, FITTERS or ELECTRICIANS

Trade Union rates of pay are in operation with opportunities to earn bonus. Recreational and welfare facilities are available; there is a pension fund and a Profit Sharing Scheme. A subsistence allowance will be paid pending the allocation of a house.

Apply in writing to the Labour Officer,

IMPERIAL CHEMICAL INDUSTRIES LIMITED
WILTON WORKS,
MIDDLESBROUGH.

ELECTRICAL ENGINEERS

The Motor Accessory Division of S. SMITH & SONS (ENGLAND) LTD., with Headquarters at Cricklewood, N.W.2, have vacancies for Electrical Engineers who possess knowledge and experience of automation control circuits and timers. Electrical trade apprenticeship is essential.

Applicants must be capable of using all types of electrical instruments and be qualified to H.N.C. standard or equivalent.

The Company offers first-class amenities and a permanent progressive position. Salary according to age and experience.

Write in strict confidence, quoting reference SM.416, to:—

The Staff Manager,
S. SMITH & SONS (ENGLAND) LTD.,
Cricklewood, LONDON, N.W.2

COMMONWEALTH OF AUSTRALIA

WEAPONS RESEARCH ESTABLISHMENT

STAFF FOR WOOMERA ROCKET RANGE

The Department of Supply invite applications for employment in the following vacancies at the Woomera Rocket Range, South Australia.

SENIOR EXPERIMENTAL OFFICER
(a number of positions)

SALARY: £2,135 to £2,330 (Australian Currency).

DUTIES: Direct the work of a section of the Range staff engaged on:—
(a) The operation, calibration, maintenance and modification of all telemetry ground equipment.
(b) The operation, calibration, maintenance and modification of all timing, intercom and closed-loop TV systems. Provision and servicing of all electronic test equipment.
(c) The servicing and calibration of all range optical instrumentation. This includes a considerable amount of electronic timing and servo equipment.

QUALIFICATIONS: An appropriate degree or equivalent qualifications. Extensive experience in one or more of the fields quoted above.

EXPERIMENTAL OFFICER, GRADE 3
(a number of positions)

SALARY: £1,730 to £1,950 (Australian Currency).

DUTIES: Supervise the work of staff engaged on:—
(a) The operation, servicing and modification of Radio Doppler and Missile Break-up systems.
(b) The operation, servicing and modification of wide bandwidth telemetry equipment at various places on the Range.
(c) The operation and servicing of digital data equipment used for transmitting the position of missiles and satellites.
(d) The provision and servicing of all electronic test equipment and closed-loop TV systems.

QUALIFICATIONS: An appropriate degree or equivalent qualifications. Several years experience relative to one or more of the fields quoted above.

SENIOR TECHNICAL OFFICER GRADE 1
(Two positions)

SALARY: £1,678 to £1,780 (Australian Currency).

DUTIES:
(a) Supervise staff engaged on the operation and servicing of telemetry ground equipment at various points on the Range.
(b) Operate and service equipment used for tracking and telemetry of manned satellites for the Mercury Project.

QUALIFICATIONS: Academic qualification and experience in one or both of the above fields to be stated.

GENERAL CONDITIONS

ALLOWANCES: At Woomera an allowance of £A120 per annum is payable to a married man maintaining a family; £A70 per annum to single persons.

HOUSING: Married accommodation will be made available within a reasonable period.

TRAVEL: Cost of First Class travel to Australia for successful candidates and their families (wife and dependant children) will be borne by the Commonwealth in the case of all positions except those of Senior Technical Officer.

Successful applicants for Senior Technical Officer positions will receive assistance from the Commonwealth in arranging migration.

CONTRACTS: For certain of these positions, contract employment will be considered. Details may be had on application.

APPLICATIONS: Forms available from the Senior Representative (AV. 110/6), Department of Supply, Australia House, Strand, London, W.C.2, with whom completed applications should be lodged as soon as possible.

Hawker Siddeley Aviation LIMITED

GUIDED WEAPONS

A. V. ROE & CO, LIMITED

Weapons Research Division, Woodford, Cheshire

Interesting and progressive posts are available in the TRIALS DEPARTMENT of this expanding Division.

The Division is engaged on the design of the air to ground strategic guided missile for the R.A.F. 'V' Bombers—BLUE STEEL.

Post	*Nature*	*Requirements*
(1) ELECTRONIC DEVELOPMENT ENGINEERS	to design and engineer missile telemetry and instrumentation equipment.	Applicants should possess a degree or H.N.C. and have experience in modern electronic techniques, including the applications of transistors and printed circuits.
(2) ELECTRONIC ENGINEERS	to work on pre-flight testing and preparation of control and telemetry systems, propulsion electrics, and safety circuits, in guided weapons.	H.N.C. standard.
(3) ELECTRONIC ASSISTANTS	to assist engineers in paragraphs 1 and 2.	O.N.C. standard.
(4) MECHANICAL ENGINEERS	to work on pre-flight testing and preparation of Hydraulic propulsion and refrigeration systems in guided weapons.	H.N.C. standard.
(5) MECHANICAL TECHNICAL ASSISTANTS	to assist engineers in paragraph 4.	O.N.C. standard.
(6) ELECTRICAL/ ELECTRONIC DRAUGHTSMEN	to work on the production of electronic or electro-mechanical drawings to Ministry requirements.	O.N.C. or similar qualifications and relevant experience.
(7) ELECTRONIC TECHNICAL ASSISTANTS	to test, programme, and service Missile Telemetry and associated equipment. The work, which includes the testing of prototype equipment, the manufacture of test equipment, and the sevicing of commercial test gear, is both interesting and varied.	Considerable experience in one or more of the following fields: a. Servicing or testing of industrial electronic or electro-mechanical equipment. b. Commercial radio and television servicing. c. 'Third line' servicing of electronic equipment in one of the services.
(8) ELECTRONIC TECHNICAL ASSISTANTS	to plan the layout of components and build prototype electronic equipment, and to wire up pre-production models in order to prove drawings prior to full production.	Considerable experience in wiring electronic equipment, and a basic knowledge of electronic circuitry.

Salaries are appropriate to qualifications and experience and are regularly reviewed.

The Division is situated on an airfield in rural Cheshire, close to housing and shops and on main bus routes. A Superannuation scheme is in operation and there are good Canteen facilities.

Applications, quoting Ref. TD/R.212/C should be addressed to:

The Personnel Officer,
A. V. Roe & Co. Limited, Greengate, Middleton, Manchester

A SENIOR TEST EQUIPMENT ENGINEER

HAWKER SIDDELEY AVIATION

is sought to assume responsibility for the design and development of equipment used to test missile control circuits. Preference will be given to graduates, but applicants with H.N.C. in electrical engineering or those who are members of an appropriate institution are also invited to apply. Experience of electronic servo testing, modern techniques of A.C. and D.C. measurement also H.M. Services requirements for missile ground equipment would be an advantage.

THE DE HAVILLAND AIRCRAFT COMPANY LIMITED

Rented housing may be available after a reasonable waiting period.

Please write, giving your age, qualifications and experience to

The Personnel Manager (Ref. S.H. 170),
THE DE HAVILLAND AIRCRAFT COMPANY LIMITED,
Gunnels Wood Road, Stevenage, Hertfordshire.

MULLARD EQUIPMENT LIMITED
51-55 GARRATT LANE,
LONDON S.W.18.

have a vacancy for a

TECHNICAL AND COMMERCIAL ASSISTANT

Applications are invited from men experienced in electronic systems, aged between 25 and 30, who have served an apprenticeship and have obtained H.N.C., including electronics or tele-communications, or an equivalent qualification. Applicants must be interested in the commercial aspects of electronic systems but need not have commercial experience. The starting salary will be in the region of £1,000 p.a.

The appointment will be based in Central London until September 1961 and thereafter in Crawley Sussex. The Company may be able to help with housing problems.

Please write, with brief particulars only, to the
COMPANY PERSONNEL OFFICER

GROUP LEADER · Electronics

A Company, well-known and expanding in the Semi-conductor field, has established a group of engineers to develop static switching and requires a Group Leader to control and expand this team.

Electronic Engineers are invited to apply for this position which demands ability to inspire and lead, together with technical competence of a very high order in this field.

The appointment carries senior staff status, and a salary of about £1,500 per annum is envisaged.

The prospects of further advancement for the selected applicant are excellent.

Please reply, giving full details, to:
Box No. 5247, Electronic Engineering.

ROLLS-ROYCE

AERO ENGINE DIVISION

are making ever increasing use of electro and electronic measuring techniques in the development of aero engines.

They have

VACANCIES

for men who have experience in

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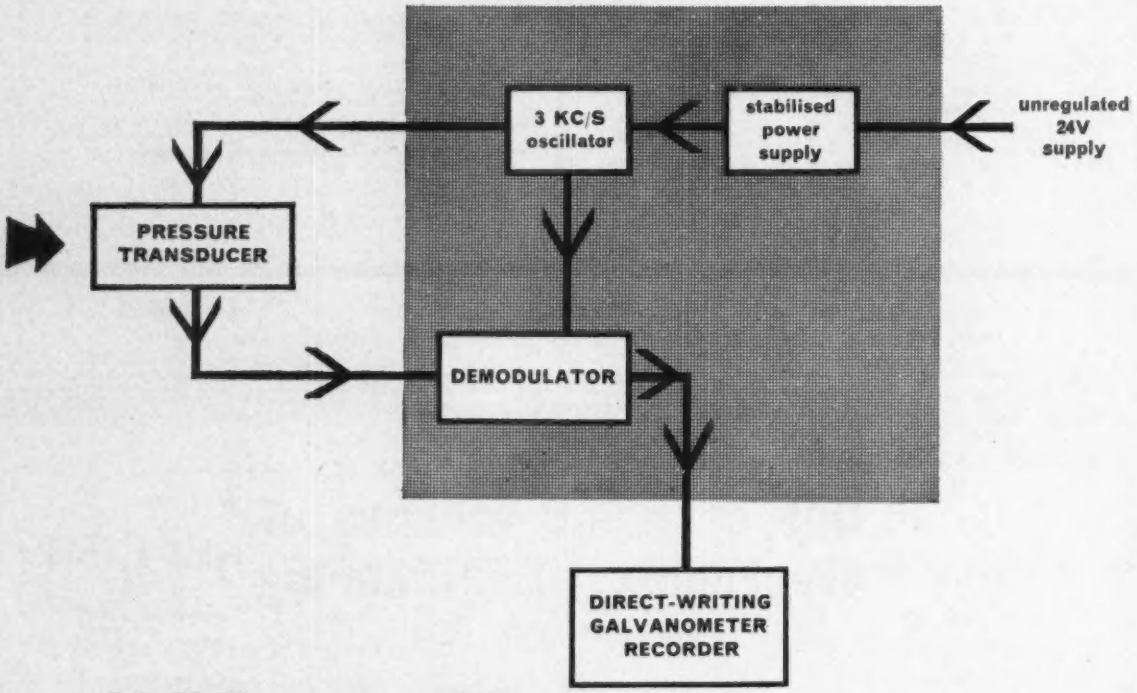

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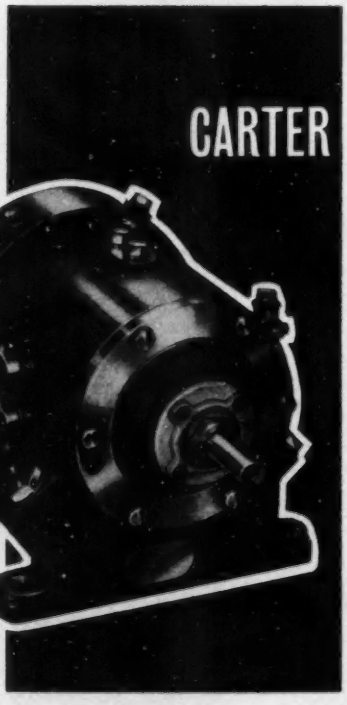

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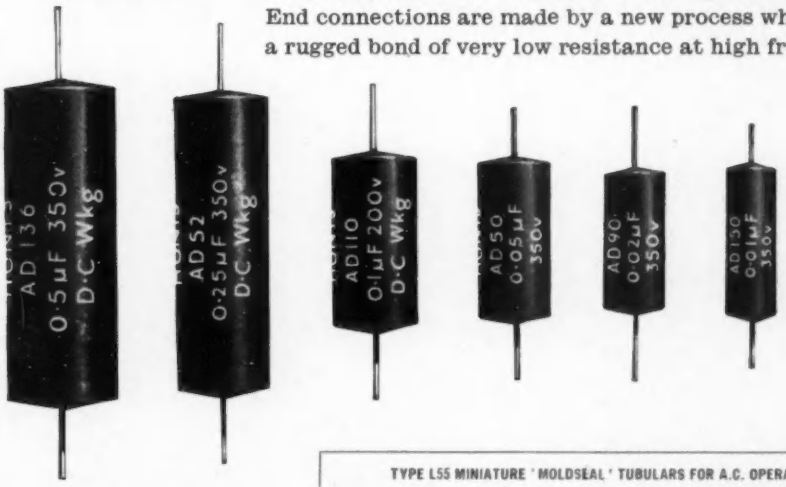

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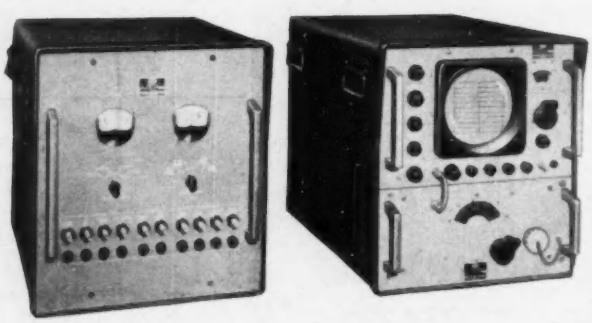

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